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A SUMMARY OF THE STATE-OF-THE-ART IN MICROFILM DOCUMENT STORAGE AND RETRIEVAL SYSTEMS

The Staff
of
Reconnaissance and Intelligence Data Handling Branch

TECHNICAL REPORT NO. RADC-TR- 67-496
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Rome Air Development Center
Air Force Systems Command
Griffiss Air Force Base, New York

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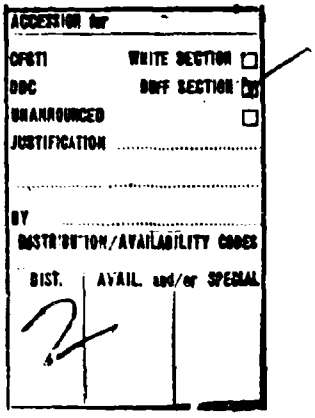

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The Staff
of
Reconnaissance and Intelligence Data Handling Branch

GORDON ASSOCIATES, INC
Long Branch, N. J.
9/67 140

FOREWORD

This technical report prepared under project 9117 has been reviewed by the Foreign Disclosure Policy Office (EMLI). It is not releasable to CFSTI because it contains information embargoed from release to Sino-Soviet Bloc countries by Air Force Regulation 400-10, "Strategic Trade Control Program."

This technical report has been reviewed and is approved.

Approved: William B. Moore
WILLIAM B. MOORE
Chief, Recon Intel Data Handling Branch
Intel & Info Processing Division

Approved: T. Howard Davis
T. HOWARD DAVIS
Colonel, USAF
Chief, Intel & Info Processing Division

FOR THE COMMANDER: Irving J. Gabelman
IRVING J. GABELMAN
Chief, Advanced Studies Group

ABSTRACT

This document is a partial review and summary of the state-of-the-art in information storage and retrieval systems concentrating specifically on microfilm based systems for document storage and retrieval. The data contained herein provides typical examples of such systems including cost data.

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I. INTRODUCTION

This report is a partial review and summary of the state of the art in information storage and retrieval, concentrating specifically on microfilm-based systems for document storage and retrieval.

A complete discussion of document storage and retrieval would require a presentation on indexing techniques and index file processing. This is beyond the scope of this report and not essential to an understanding of the present subject. The only requirement imposed on a microfilm handling system by the document index is that the final selection numbers or codes provided by the index be recorded on the microfilm so that they can be read either by retrieval personnel or by a machine. The specific microfilms of interest can then be selected, either manually or by a retrieval mechanism built into the system, and routed to the appropriate station for further attention. This is an existing feature of all the approaches to be discussed.

There are two objectives of a document storage and retrieval system. The first is to achieve a drastic reduction in the amount of space required to store the document collection. The second is to establish a storage record of optimum size, shape, and storage density, which can be handled rapidly and inexpensively by machines for retrieval and preparation of dissemination products. Microfilm-based systems represent potentially the most reliable and cost-effective means now available for this purpose. They achieve the objective of miniaturization by optically reducing the document pages and photographing them on film of very high quality.

Most approaches to microfilming are about equally successful in accomplishing this, achieving a 92- to 97-percent reduction in the amount of space needed for document storage. The critical problem, however, lies in the satisfactory accomplishment of the second objective. Its attainment lies in achieving the best balance between (1) the physical size of the record and (2) the number of pages to be stored on it. These two variables interact to determine the amount of optical reduction required, within a narrow range. That, in turn, greatly influences

both the cost and the reliability of the system. These variables, and the practical considerations in which they are embedded, are discussed in detail in Section III of this report. The relative success with which current microfilming concepts achieve this second objective is discussed in Section IV.

It is the conclusion of this report that the 4-by-6-inch microfiche format, containing 60 document-page images per record, is the best of today's approaches for technical document storage and retrieval in the Federal Government. It is considered to be an adequate concept for most of the applications that can be foreseen for at least the next 10 years. In this connection, this report concurs with conclusions reached earlier by DDC, AEC, NASA, and the Federal Council for Science and Technology. Perhaps 90 percent of most technical reports, documents, dossiers, case histories, and similar items in which the consecutive pages are subject related are less than 300 pages in length, and can be stored on 1 to 5 microfiches. Over one-half of all such items are estimated to be less than 60 pages in length and can be stored on a single microfiche. The 60-page format is a good compromise between the conflicting requirements of (1) unifying subject-related pages; (2) keeping unrelated items separated, and therefore easily retrieved for other users or removed for obsoletion; and (3) having a minimum number of only partially filled microfiches in the working files.

After this introduction, this report presents a brief historical perspective (Section II); a discussion of the basic elements of a microfilm document storage and retrieval system, and the principal operational factors affecting them (Section III); a summary of the most important systems commerically available and a detailed discussion of the best three of these (Section IV); and conclusions and recommendations (Section V). A summary of microfilm equipments commercially available is presented in the appendix.

II. HISTORICAL PERSPECTIVE

The concept of automating information storage and retrieval is not new. The history of this branch of technology begins in 1839 with the first known instance of microphotography. John Benjamin Dancer of Manchester, England, installed a microscope lens in a camera and succeeded in making a microphotograph of a document. The first patent for a commercial microfilm capable of recording images of very small scale was issued in 1859 to Rene Dagron of France. Dagron is also credited with the personal supervision of the sending of microfilmed dispatches by carrier pigeon, during the seige of Paris in 1870. This was the first known use of microfilm as anything other than a novelty.

From 1851 on, photographers, scientists, and others advocated the use of microfilm for libraries and archives. By 1927, four criteria had been established to define an optimum information storage and retrieval system:

- Use of photographic storage media for records and items to be subsequently selected and retrieved.
- Recording of selection criteria such as index terms or accession numbers on the same physical unit as the information items to be selected.
- Mechanical means for manipulation and search.
- Means for providing replica copies of the information selected.

Today there is very little to add to these basic criteria. Even so, it was not until 1931 that a patent for a mechanical retrieval device was filed. This was granted in Germany to Emmanuel Goldberg, who proposed a machine for the retrieval of items in image format, using either punched holes or transparent zones on photographic film, a selection mask corresponding to the pattern of holes on the item sought, and a photocell matrix to detect the matching of the selector mask with the index pattern. In 1932, Watson Davis and Dr. Vannevar Bush were discussing the development of an information retrieval device in the

United States. In 1934, Atherton Seidell, in an article in Science, described what was perhaps the first concept for the aperture card:

> It is probable that the most satisfactory system will be one in which 16mm film is used, and from such strips of negatives of printed pages, positives will be prepared and these mounted on windows in filing cards. Such cards need not be much larger than 10 x 15 centimeters and have sufficient space for typewriting the author's name, title of paper and classification number.

In 1938, Dr. Bush had formalized his own ideas well enough to propose the ancestor of the current Rapid Selector device. By 1945, Dr. Bush had taken note of the growing cascade of technical publications stimulated by the immense scientific and technical effort accompanying World War II, and characterized it as an "information explosion." He pointed out that information handling technology had not kept pace with the production of new knowledge:

> There is a growing mountain of research. But there is also today an increased awareness that we are being bogged down as specialization extends .... The investigator is staggered by the findings and conclusions of other workers--conclusions that he cannot find time to grasp, much less remember as they appear.
>
> The difficulty seems not to be so much that we publish unduly, in view of the extent and variety of present day interests, but rather that publication has been extended far beyond our present ability to make real use of the record. The summation of human experience is being expanded at a prodigious rate and the means we use for threading through the maze to the momentarily important item is the same as it was during the days of square rigged ships.

Today this is not the problem. In fact, since the early 1950's, technological advances applicable to the improvement of information handling have been so rapid that each new development steps on the heels of the one ahead of it. Basic inventions have been made, such as new and improved photographic media and processes and the development and perfection of electrostatic printing. An important event has

been the development of a number of different unit-record formats. such as the aperture card, the microcard, and the microfiche. These have proved to be valuable alternatives to the older roll-film format, and have been key factors in broadening the applicability of microfilming technology into new operational areas.

It is true that backlogs of hard-copy documentation continue to grow, but now it is because organizations with information-handling problems have difficulty in assessing the probable future trends in the state of the art and are hesitant to commit themselves to a particular approach that may soon become obsolete. On review, however, it is quite clear that the present state of the art is at a point such that it is not only adequate to handle, or at least dramatically improve, the present situation in technical document storage and retrieval, but that, in addition, must future development activity over the next 5 to 10 years will go into continued exploitation of the present level of basic technology. This means that organizations committing themselves now, say, to microfiche installations, can expect to be able to add modular improvements to that capability without being required to make a change in their basic concept of document storage and handling.

It is the purpose of this paper to summarize the state of the art, to make recommendations on the application of present capabilities to today's problems, and to suggest some of the capabilities that future developments in microfilm document storage and retrieval will probably bring.

III. BASIC ELEMENTS OF A MICROFILM DOCUMENT STORAGE AND RETRIEVAL SYSTEM

Regardless of specific design features or construction details, the same eight basic elements enter into all complete systems for microfilm document storage and retrieval. These are named and characterized briefly below. The balance of this section takes up each of these elements in order, treating each in detail and discussing the variations that must be considered in different types of systems and in various configurations and operating environments.

A. Summary of Microfilm System Elements

It will be noted that some of the elements listed below are pieces of equipment that go into the mechanisation of a storage and retrieval system, while others relate more to the nature of the materials handled by the system. The discussion is purposely arranged in this manner because these elements give rise to all the significant equipment-related variables that must be evaluated when selecting components to fit the requirements to a specific installation. The rest of the knowledge required to design a document storage and retrieval system must come from operations analysis and study of specific files and their use, in each case. General statements will be made, however, as to the applicability of a given approach for a specific use, as the occasions arise in the detailed discussions of subsection B.

1. Format

This refers to the finished microform itself. The important formats are as follows:

- Roll film wound on a spool, often packaged in a cassette
- Strip film, usually protected by acetate jacket cards
- Sheet film (microcard format)
- Opaque prints (microcard format)
- Film chips, mounted in a cardboard holder (aperture card format)

The format and its size are two important variables in determining both the mechanization of the system and the effectiveness and convenience of the system to the user, for his particular application.

2. Reduction Ratio

In microphotography the film image is reduced to the point that the document is no longer legible to the unaided eye. The size of the document image, as compared with the size of the original document, is expressed in terms of the reduction ratio. For example, when a document 19 inches long is reduced to 1 inch of film, the reduction ratio is 19 to 1. This is commonly expressed as 19:1 or 19 x. The reduction ratio is an extremely important variable in the design of a reliable document storage and retrieval system.

3. Film

This is the basic data storage medium. It is a photographic image-recording material of high resolution, usually in 16-mm or 35-mm sizes. Some special applications also utilize 70-mm and 105-mm film. A number of emulsions, such as silver halide, diazo, and kalvar are also available, and are used at different places in various systems, where their respective properties are of advantage.

4. Camera

This is the device for imaging documents on the film. Cameras used in microfilming are of two types: rotary and planetary. Selection of one or the other type depends on the degree of precision required in placing the image on the film.

5. Film Processor

This is the means for developing the film and fixing the image permanently on the storage medium. Processors vary widely in cost. They may be completely manual, semiautomatic, or fully automatic.

6. Reader

The reader is a device to enlarge and display the image from the microform on a viewing screen for the user's inspection.

7. Hard-Copy Printer

The hard-copy printer is a reproduction device that makes a facsimile of an image, enlarged from the microform and printed on paper. The printer is often housed in the same cabinet as a reader, the combination being called a reader-printer. The printed facsimile is often referred to as a blowback.

8. Film Store

This is the storage unit for housing the working master file of reduced documents on microforms. Film stores range in complexity from simple cabinets with drawers designed to hold units of the required size and shape to variously mechanized units. The more sophisticated of the latter present specifically selected microforms at a retrieval station. Others present small portions of the total store, such as a drawer or rotary bin, at the retrieval station. Further search and selection of the specifically desired records is carried out manually within the drawer or bin.

B. Detailed Discussion of Microfilm System Elements

This section identifies and discusses the variables relevant to microfilm system planning, as they are subsumed under each of the basic system elements summarized above. In some cases, acceptable ranges of quality, performance, or property have already been defined by Government specification or by interested professional groups in industry. These are pointed out where appropriate. In other cases, data are presented from experimental literature, from manufacturers' information, and from the consensus of expert professional opinion.

1. Format

Format refers to the physical characteristics of the finished microform. The five important microfilm formats are described below:

- Roll Film Wound on a Spool

  Individual documents are photographed on rolls of 16-mm or 35-mm film. Each individual page occupies one frame.

The number of frames to a standard 100-foot roll varies with the reduction ratio used and the size of the individual document. The normal range is from 1,200 to 2,400 frames per roll. Roll film may be used as the source for any other microform, as a source for printed or hard copies, or as a retrieval vehicle. Roll microfilm, when used as a dissemination medium, is often packaged in a cassette and is self-threading in the viewer mechanism.

- Strip Film

Film strips are made from roll film, are usually from 3 to 5 inches in length, and contain 4 to 10 letter-size images. The film strips may be negative or positive, and may be used for projection, for printing, or for viewing. They are often inserted into acetate jacket cards for handling. The jacket card is usually 3 x 5 or 4 x 6 inches in size and contains several slots, or channels, into which the film strips are inserted. This serves the purposes of (1) keeping the films flat, (2) protecting the films from scratches, and (3) providing a holder of uniform size to facilitate filing and inserting into viewers and printers.

- Microfiche

This microform is a negative (or positive) sheet of film. The sheet has been standardized at 4 x 6 inches (105 x 148 mm), although other sizes are still used, including 3 x 5 inches (library catalog card), 5 x 8 inches (report size card), and 7-3/8 x 3-1/4 inches (electric accounting machine--EAM). Each 4 x 6-inch sheet usually contains up to 60 pages of 8-1/2 x 11-inch material, or equivalent, in 5 rows of 12 images each. Microfiche may be made from roll film by cut-and-paste methods, or may be made with a step-and-repeat camera that automatically positions the individual image in the appropriate column.

- Microcard

  Microcards are positive 3 x 5-inch, opaque prints prepared from roll film cut into film strips. Each side of the card can hold up to 40 letter-size pages. Descriptive information can be printed on the top or reverse side of the card.

- Aperture Cards

  An aperture card is an EAM card, modified to contain a frame of film (usually 35 mm) permanently mounted in a die-cut window. The card may be duplicated positively or negatively and may be processed through EAM equipment. Each aperture card contains from one to eight letter-size pages. They are also often used to record engineering drawings and blueprints.

It will be recalled that the two objectives of a microfilm document storage and retrieval system are (1) miniaturization and (2) the establishment of a storage record that can be rapidly and inexpensively handled by machines for retrieval and preparation of dissemination products. In this second connection, there is considerable variation in flexibility among the basic microforms. Depending on the specific application, the need to generate dissemination products may vary quite broadly, both in type and amount. For example, a centralized document-processing facility may find it desirable not only to convert all incoming items to a uniform storage format, but also to disseminate a variety of duplicate microforms to other facilities, which, in turn, generate hard-copy facsimiles as required. Or, again, such a facility may wish to convert all incoming items to a uniform storage medium, but disseminate only hard-copy facsimiles to other facilities in relatively large numbers. Some microforms can be used for viewing, for reproduction purposes, and for making duplicate microforms. Others either cannot be used for making duplicate microforms or can be used only for making certain other types of microforms. Exhibit 1 illustrates the relative flexibility of the basic microforms in this connection.

EXHIBIT 1 - BASIC MICROFORM CAPABILITIES

Microform	Can Be Used To Produce							
	Roll Film	Film Strip	Micro-fiche	Micro-Card	Aperture Card	Hard Copy	Offset Plate	Vellum Master
Original Document	X	X	X	X	X	X	X	X
Roll Film	X	X	X	X	X	X	X	X
Film Strip		X	X	X	X	X	X	X
Microfiche		X	X	X	X	X	X	X
Microcard						X		X
Aperture Card					X	X	X	X

Along with these capabilities and limitations related to production and dissemination, there is one other factor to be considered in operational use. When obsolete, documents stored on roll film cannot be removed from the film store other than by cutting and splicing the film. Rather than handle the film so much, it is usually more practical simply to leave the out-of-date items on the film until the entire roll can be obsoleted. This means that significantly more obsolete information must remain in a roll-film file than in unit-record files, in which there will be a relatively small number of images on each record. Microfiche, microcards, and aperture cards will tend to become obsoleted in terms of entire cards, or sets of cards, thus allowing file maintenance to be undertaken with relative ease.

2. Reduction Ratio

In microphotography, the film image of the original document is reduced in size to the point that it cannot be read by the naked eye. Just how great this reduction may be depends on the size, detail, and contrast of the material printed on the original documents and the legibility desired in the film copies. The size of the microimages, as compared with the size of the original document, is expressed in terms of diameter, or reduction ratio. For example, when a reduction ratio of 19 to 1 (commonly expressed as 19:1 or 19 x) is used, it is possible to reduce a document measuring 19 inches in length to 1 inch of film. More images can be recorded on the same amount of film by using a higher reduction ratio, thus resulting in film economy and a lower cost per item photographed. The reduction ratio, therefore, is the most significant measure of the storage capacity of a microfilm system.

a Parameters Affecting Reduction Ratio

The factors governing the reduction ratio at which images are to be recorded in a given system comprise at least the following:

(1) The Resolving Power of the Human Eye

For error-free reading of print at normal viewing distances, it has been found that the resolving power of the human

eye is about 7 to 12 lines per millimeter. The higher the resolving power of an individual's eyes, the greater is his visual acuity.

(2) The Resolving Power of the Film

If a film emulsion has a resolving power of 100 lines per millimeter, then when a National Bureau of Standards Resolution Test Target is contact-printed on it and developed under laboratory conditions, it will be possible to discriminate, through a microscope, the lines of the test pattern containing 100 lines per millimeter. Government specifications (MIL-M-9868) state that a resolution of 100 to 120 lines per millimeter is acceptable for microfilm recording at reduction ratios of from 16 x to 30 x. The average Kodak microfilm emulsion has a resolution of approximately 250 lines per millimeter. Kodak's Lippman emulsions, considered to have the highest obtainable resolution, measure in excess of 2,240 lines per millimeter.

The resolving power of the medium relates to the resolving power of the human eye in the following way. Tests conducted by the National Bureau of Standards show that when letters and numbers are microphotographed at reduction ratios such that the height of the character is equivalent to about four resolution lines, it is barely legible. For example, consider a microfilm with a capability of resolving 100 lines per millimeter. Four of the hypothetical resolution lines are equivalent to 0.04 millimeters on the film. Six-point type is approximately 1 millimeter in height. At a reduction ratio of 25 x, a 1-millimeter character would have a height of 0.04 millimeters in the microimage. Type this small, then, would be barely legible at 25 x reduction, when microimaged on film of 100 lines per millimeter. If such a microimage were enlarged and printed, it would be seen that the letters were veiled and broken and that many were unreadable.

The same study showed that, for error-free reading of printed material, the reduction ratio of document microimages should be such that the heights of the reduced letters and numbers are equivalent to six or seven resolution lines. This value corresponds to the maximum resolution of the human eye. By this rule, printed material in six-point

type should be reduced no more than about 14 x on film with a resolution of 100 lines per millimeter. The final finding of the Bureau of Standards study was that legibility of characters in microimages continued to improve with increasing size, relative to film resolution, until the character height was equivalent to about 10 to 12 resolution lines. Thereafter, no discernible improvement was noted.

To relate this data to more familiar examples, the usual office typewriter prints in 12-point type, which is about 1.6 millimeters high. Exhibit 2 shows the relationship between reduction ratio and the quality of the microimage that would be obtained if this page were to be reduced on each of three types of microfilm that have been discussed.

(3) The Number of Successive Regenerations

No well-designed microfilm document storage and retrieval system circulates its original negatives to users. A duplicate working file is made, often from diazo film stock. From the diazo working file, either duplicate microforms are made or hard copy is printed and disseminated. In any case, the user is almost always working with a third- to fifth-generation reproduction of the original document. A study done by Wright Air Development Center shows that in batch processing, with the usual quality control standards observed, each successive regeneration of a film, down to the prints finally disseminated, retains an average of only 80 percent of the resolution measurable in the previous generation. In other words, if a master negative is made, with a resolution of 100 lines per millimeter, the diazo working copy will contain only 80 lines per millimeter of the original data, and the dissemination copy will retain only 64 lines per millimeter of the original information.

One way to retain this information is to pack it less densely, initially. This amounts to a lower reduction ratio. Using the table presented in the previous discussion of resolution as a guide, it is possible to recompute the maximum allowable reduction ratios in order to retain satisfactory resolution in the dissemination copies. In practice, the final user usually gets a third-generation copy. Occasionally, when microrecords are redistributed from central facilities through two levels of

EXHIBIT 2 - MAXIMUM ALLOWABLE REDUCTION RATIO TO PROVIDE QUALITY SHOWN AT LEFT IN SILVER HALIDE NEGATIVES

	Minimum Mil Spec Microfilm: 100 l/mm	Typical Kodak Microfilm: 250 l/mm	Kodak Lippman Emulsions: 2,240 l/mm
Barely Legible: Four Resolution Lines Per Character	40 x	100 x	896 x
Error-Free Reading: Seven Resolution Lines Per Character	23 x	57 x	515 x
Best Quality: Twelve Resolution Lines Per Character	13 x	33 x	298 x

Note: (1) The values in the table show the maximum reduction that could be made of a document printed in 12-point type and still obtain the quality levels described on the left side, for each of the three types of microfilm. Bear in mind that this refers only to the first-generation, silver-halide negative.

subordinate regional facilities to the field, the users may get fifth-generation copies. Exhibits 3 and 4 show the maximum reduction ratios allowable in the original negative, to obtain acceptable qualities in the third- and fifth-generation copies, respectively, for the same types of microfilm.

These values suggest two things: First, the Government specifications for microfilms to be used in systems that have two-step dissemination practices are really not adequate. A minimum resolution figure for microfilms to be used under such operational conditions is 250 lines per millimeter. Secondly, even when using the higher quality microfilms, the maximum allowable reduction ratio should be no greater than about 24 x. Under these conditions, it will still be possible to obtain copies in the fifth generation that are of sufficient quality to permit error-free reading.

(4) The Resolving Power of the Optical System

The final factor affecting the reduction ratio is the resolving power of the optical system. The theoretical optical limit for such systems is in the vicinity of a reduction ratio of about 600:1; however, there are other factors to consider. Even if the system will be used under conditions such that successive regeneration of document images is not a limiting factor, there is a problem in that with increasing reduction ratio the film transport mechanisms in cameras, readers, and printers become extremely complicated. The greater the number of images stored within a given area of film, the more difficult is the problem of indexing, locating, and accurately registering any single one of them. Eventually a point is reached at which the cost and complexity of the image-registration mechanism discourage the use of higher reduction ratios.

Considering all the factors discussed above, it can be estimated that the range of reduction ratios within which almost all conceivable applications for microfilm document storage and retrieval will fall is between 15:1 and about 200:1. The great majority should fall between about 15:1 and 40:1.

EXHIBIT 3 - MAXIMUM ALLOWABLE REDUCTION RATIO TO PROVIDE QUALITY SHOWN AT LEFT IN THIRD-GENERATION COPIES

	Minimum Mil Spec Microfilm: 100 l/mm	Typical Kodak Microfilm: 250 l/mm	Kodak Lippman Emulsions: 2,240 l/mm
Barely Legible: Four Resolution Lines Per Character	26 x	64 x	574 x
Error-Free Reading: Seven Resolution Lines Per Character	14 x	37 x	330 x
Best Quality: Twelve Resolution Lines Per Character	8 x	21 x	190 x

EXHIBIT 4 - MAXIMUM ALLOWABLE REDUCTION RATIO TO PROVIDE QUALITY SHOWN AT LEFT IN FIFTH-GENERATION COPIES

	Minimum Mil Spec Microfilm: 100 l/mm	Typical Kodak Microfilm: 250 l/mm	Kodak Lippman Emulsions: 2,240 l/mm
Barely Legible: Four Resolution Lines Per Character	17 x	41 x	367 x
Error-Free Reading: Seven Resolution Lines Per Character	9 x	24 x	211 x
Best Quality: Twelve Resolution Lines Per Character	5 x	14 x	121 x

b. Practical Considerations

As discussed earlier, the way by which one determines a practical reduction ratio is to see how many lines per millimeter will be resolved in the form enlarged for viewing with a given set of optics and a given emulsion.

Generally, documents are microfilmed at the lowest reduction necessary to record the images on the film being used. Technically, present-day cameras and some films can microphotograph records at reduction ratios considerably greater than 44:1, but the practical use of higher reduction ratios is limited by the current design of reader-printer machines now on the market.

Special systems based on document reduction ratios of 60:1 (Kodak Minicard), 140:1 (AVCO Corporation), and 200:1 (National Cash Register Company) have been successfully used for high-density document storage, but they require special (and expensive) equipment exclusively designed for these specific systems.

The reduction ratio normally used for recording ordinary letter-size or legal-size documents (8-1/2 x 11 through 8-1/2 x 14) is either 17:1, 19:1, or 24:1. For engineering drawings, the reduction ratio is anywhere from 8:1 to 30:1. The approximate number of documents that can be recorded on a 100-foot roll of film is 1,800 images at 17:1, 2,400 images at 19:1, and 3,000 images at 24:1. The number of images per 100 feet of film varies with the size of the record and the degree of reduction. For extimating purposes, the following formula is generally used:

$$\frac{\text{Reduction Ratios} \times 1{,}200 \text{ Inches}}{\text{Longest Dimension of Document (in inches)} + \text{1/2 Inch for Each Document}} = \text{Number of Images Per 100 Feet of Film}$$

Example (Engineering Drawings 35 Inches in Width):

$$\frac{30 \times 1{,}200}{35 + 0.5} = \frac{36{,}000}{35.5} = 1{,}014 \text{ Images}$$

Most commonly used reduction ratios appear to be between 15:1 and 26:1. Reduction ratios need not be held constant within a system. Camera reduction ratios may be increased to meet larger original sizes. Reader ratios may be increased for clarity or reduced for efficiency. Blowback ratios for printing tend to be somewhat less than camera reductions within the same system for standardization of print sizes and for reduced costs.

3. Film

Microfilm stocks now widely available are of three basically different kinds. The first, and most commonly used, is made up of two elements: an acetate base and a photosensitive layer of silver halide called the emulsion, which is bonded to the base. This is identical in construction to the film used in everyday amateur photography. The second, also widely used, is diazo film stock. Diazo differs from silver halide film in several important respects, and these differences give diazo very useful properties for certain applications in document storage and retrieval. The third type is called kalvar, and is entirely different in concept from either diazo or silver halide film. In addition to the question of film stock, there are three other important variables to consider under the general topic of film: resolution, density, and size. These six factors are discussed below.

a. Silver Halide Film

When an image is formed on the emulsion of a silver halide film, a chemical change takes place, triggered by the energy transmitted to the film by light in the visible spectrum. During development, those particles of silver in the emulsion receiving the least light become the lightest, while those receiving the most light become the darkest. Particles receiving intermediate amounts of light turn shades of grey in proportion to the amount of light impinging upon them during exposure. When the original, or first-generation, silver halide film is developed, then, the image is in negative form; i.e., lines that were black in the originally photographed material appear as white lines

in the negative. This first-generation film is usually panchromatic, which means that it is sensitive to light in all colors in the spectrum. It must therefore be developed in total darkness. When duplicate negatives are made from the master negative by contact-printing methods, orthochromatic films are usually used. Orthochromatic films and papers are colorblind in the red end of the visible spectrum and can be developed under red safelight illumination. They give superior performance when photographing only black and white materials.

Silver film is generally preferable for archival storage and recording purposes because it retains its image much better with time. Since the image is actually recorded on the emulsion, however, it is much more susceptible to tearing, scratching, pinholing, and other physical defects, and therefore must be handled as little as possible. Master record copies of documents should be made on silver halide film, but duplicate negatives must be made for use in a working file.

b. Diazo Film

This type of film is best described by contrasting it with silver halide film and then summarizing its advantages and disadvantages.

(1) Diazo is a slow film and takes longer to expose than silver halide. Development, however, is a rapid-dry process that can take place in a lighted room. Because of the speed of development, the overall duplication cycle for diazo is significantly faster than for silver halide.

(2) The emulsion of diazo is incorporated into the base material. Because of this, the diazo image is much less susceptible to damage during handling by machines. After a period of time, however, the diazo image tends to fade. This property makes it unwise to use diazo for archival purposes. However, because of the resistance of the image to physical damage during handling, diazo is better suited for use as a working file copy from which blowbacks or frequent duplicates are made.

(3) Diazo has the property of reversal development. This means that it makes a negative image when contact-printed from another negative. In creating a duplicate silver halide negative, however, an intermediate paper positive must be made. This means that the duplicate silver halide negative is actually a third-generation film, while the duplicate diazo negative is second generation. Each additional generation step incurs a loss of detail quality, as was discussed earlier.

(4) In summary, the properties of diazo film are ideally suited to its use in a working file where it may receive considerable handling. On the other hand, the property of long image retention makes silver halide film best suited for archival master copy storage. As a master copy it need be handled only when a new diazo working copy is needed. Concerning costs, the two film materials are approximately equal in cost, but diazo is cheaper to process in small quantities.

c. Kalvar Film

This storage medium, while still not widespread in use, is gaining in importance. It works on an entirely different principle than either silver halide or diazo. Rather than containing a silver emulsion, it is composed of a material which, when exposed to ultraviolet radiation, forms the nucleus of a tiny bubble at each point where the radiation impinges. These nuclei form the latent image. When simple heat is applied to the exposed material, the microscopic bubbles expand in proportion to the amount of radiation received during exposure.

The bubbles scatter light differentially, depending on their size. This is in contrast to the principle behind silver-based films, in which the darkened silver particles absorb light. The picture thus produced is of high resolution and is of rather low density in comparison with silver negatives. Its image-retention capabilities are excellent, as long as the film is kept in a temperature-controlled environment. Exposure and processing are extremely simple. Its primary application is similar to that of diazo, for information storage and retrieval applications. It has the disadvantage that it lacks the well-understood supporting technology built up around the use of silver halide and diazo film.

d. Film Resolution

Resolution is a measurable separation between the lines of a microimage test target under rigidly controlled conditions of observation. It is, in a sense, a combined measure of the imaging camera lens, the film emulsion, and the development process after exposure of the test image. In operational terms, resolution measures the ability of the lens-film-processing system to record fine detail faithfully. High resolution is clearly a requirement for any microfilm to be used for document storage and retrieval. During the measurement process, the quality of the microfilm can be determined by using the National Bureau of Standards resolution test targets. These targets, which contain test patterns of parallel lines, are photographed at the start and finish of each film roll. After the film is processed, the resolution targets are read with a microscope. A value of 100 to 120 lines per millimeter between the reduction ratios of 16 x and 30 x is considered acceptable by Government specification (MIL-M-9868).

The high standard of quality in microfilm emulsion is readily apparent when it is compared with conventional photographic film:

Property	Typical Kodak Microfilm	Kodak Panatomic Safety X
Resolving Power	250 lines per mm	60 lines per mm
Grain	Very fine	Fine
Average Cost Per 100 Feet (unprocessed 35 mm film)	$5.50	$3.95 (professional grade)

Conventional photography uses faster and more grainy films for what it terms its finest grain films than microrecording does. Microfilm negative raw stock has a 4 to 1 advantage in resolving power over the best commercial negative film used for motion pictures and still pictures. Typical Kodak microfilm is the type most often used in a conventional microfilm system. There are other microfilm emulsions[1]

[1] Kodak's Lippmann emulsion, numbered 649-GH, has a resolving power of at least 2,240 lines per millimeter.

with greater resolving power, but they are used only for special microfilm systems and require a whole family of special equipment for their exploitation.

e. Film Density

Along with resolution, the background density also governs the quality of the processed microfilm. Density is a measure of the opacity of the image. In operational terms, the density of the film determines how well the dark background of a negative page image will block light during enlarging and printing, to provide crisp, black, high-contrast copy on a clear white background.

Density is expressed in a logarithmic scale ranging from 0.00 to 3.00. The lower value represents the perfect transmission of light and the upper value represents virtually total opacity. A measurement of 1.0 to 1.2 for negative microfilms, obtained with a densitometer, is acceptable by Government specifications. The image density obtainable from virtually all films is widely controllable by varying exposure time and by varying development time during processing. Most commercial microfilm manufacturers provide exposure and processing instructions for obtaining proper density.

f. Film Size

Most commercial microfilm is currently manufactured and distributed in rolls of four common widths: 16 mm (0.6 inches), 35 mm (1.3 inches), 70 mm (2.8 inches), and 105 mm (4.1 inches). The standard raw film normally comes in unperforated 100-foot rolls; however, other lengths (50-foot rolls and 200-foot rolls) are available. Most commercially available microfilm storage cabinets are designed to receive the 100-foot lengths.

4. Cameras

The camera is one of the major items of equipment in a microfilm document storage and retrieval system. There are three major factors relating to cameras to be evaluated: (1) the basic camera type (rotary or planetary), (2) the step and repeat capability, and (3) cost. These factors are discussed in detail below.

a. Basic Camera Type

There are two basic types of microfilm camera: the rotary camera and the planetary camera. Rotary cameras, often called flow-type cameras, are very often used in commercial office applications such as banking. They are extremely simple to operate. Planetary cameras, often called flat-bed or overhead cameras, are most often used for very high-quality precision microfilming and require considerable operator training and competence for maximum results. Each is treated separately in the two sections following.

(1) Rotary Cameras

The rotary camera derives its name from the rotating drum over which input documents are fed to be photographed. It differs from the planetary camera in that the document is in motion while it is being filmed. When a document page is inserted into the machine, its leading edge actuates a tripping mechanism that turns on the camera lights and starts advancing the film. The rotation of the document and the film advance are synchronized; the image is automatically exposed on the moving film through a slit as the document passes directly in front of the camera aperture. The amount of film exposed varies according to the length of the document being filmed. The reduction ratio of the lens is also geared to the film-advance mechanism; thus, more film is exposed for a document being photographed at 17:1 than the same document being photographed at 30:1.

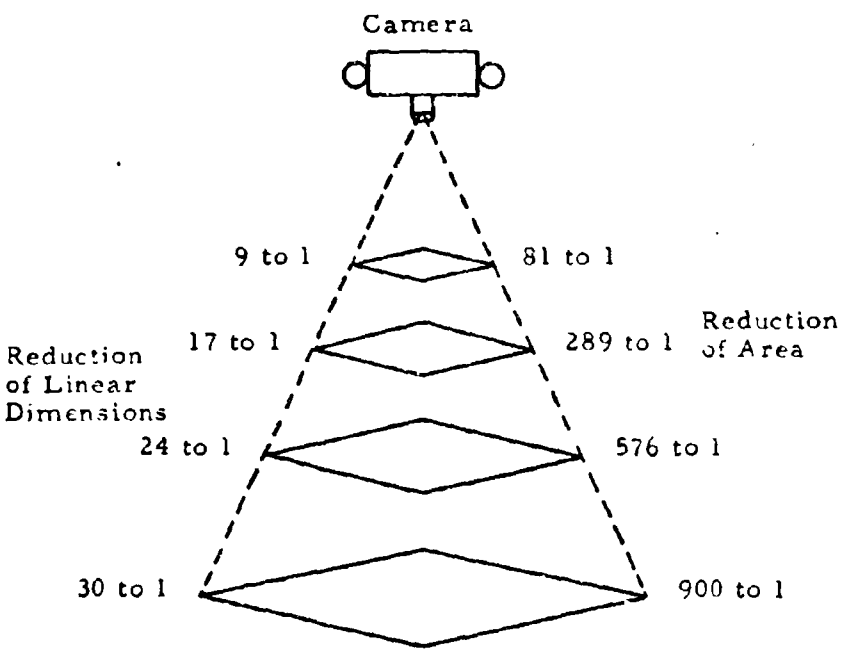
The reduction ratio of the rotary camera runs from 16:1 through 40:1. This ratio is changed by replacing the lens-block assembly with another assembly of a different ratio. Some rotary cameras photograph only one side of a document at a time, while others photograph both sides of a document simultaneously if required. By equipping the cameras with automatic feeding devices to expedite document input and transport, approximately 500 check-size items can be filmed per minute. By the hand-feeding method, approximately 40 to 60 letter-size documents can be filmed per minute, depending on the speed of the camera operator.

Normally, rotary cameras are not used for precision microfilming work; rather, they are used for low-reference type materials or temporary transit records. Header references or occasional prints from the film are the common type of file usage. The advantages of a rotary camera are in the ease of operation and in the speed with which the document can be recorded. Most of the factors dealing with the basic rules of photography (light-value reading, aperture opening, exposure time, focusing distance, and shutter speed or film advance speed) can be taken for granted, since they usually all function automatically in the rotary camera. Thus, an office girl can learn to operate the camera within a few days. The lack of manual controls to override some of the automatic features, however, sometimes results in uneven film resolution, background density, and frame size. Also, rotary cameras accept only a loose, single sheet at a time. If documents are stapled, the staples must be removed; if the documents are bound volumes, the individual pages must be physically removed from the book before they can be photographed. The labor expended for microfilming on a rotary camera therefore is reflected in the initial preparation of the documents prior to the filming step, rather than in the camera operation itself.

(2) Planetary Cameras

These are often referred to as flat-bed or overhead cameras because of their mechanical design. The document to be filmed is placed on a flat copy table. The camera is mounted on a column or arm extending over the document like an ordinary darkroom enlarger. The technique for adjusting the reduction ratio of a planetary camera is also similar to that employed with an enlarger. If the size of the document image on the film is to be increased, the camera is raised; if the image size is to be reduced, the camera is lowered. This is in contrast to the rotary camera, which changes lenses and thus can only change reduction ratio in several discrete steps. The continuously variable reduction ratio is illustrated in Exhibit 5.

Most planetary cameras use a fixed shutter speed (usually 1/2 second), and control exposure by varying the light intensity on the document to be copied. The proper light value is determined by using a light meter.



Note: The reduction ratio can be changed by substituting a different size camera lens, or by increasing or decreasing the camera distance from the document being photographed.

EXHIBIT 5 - GRAPHIC ILLUSTRATION OF REDUCTION RATIO

This type of equipment is used for microfilming bound volumes, technical manuals, engineering drawings, blueprints, charts, maps and other materials in which very high-quality reproduction is necessary. Because of the control over the quality and uniformity of the microimages, reproduction techniques producing hard-copy facsimiles in quality can be used.

The primary disadvantage of the planetary camera is the relative slowness with which documents are filmed. The fixed shutter speed, of course, imposes an absolute maximum on the throughput rate. In addition, unlike the rotary camera, many variables must be contended with before a high-quality microimage is achieved. The ability of the camera operator to evaluate every document to be photographed and to determine the proper settings and adjustments is essential in obtaining good image resolution, proper background density, correct reduction ratio, and perfect positioning on the negative. Thus a good operator cannot be trained overnight. He must have basic training in photography and supervised experience in the field of microphotography. This means a significant investment in training.

b. The Step-and-Repeat Capability

It is of interest to evaluate the usefulness of procuring a camera with this capability, when considering the implementation of a micr. fiche document storage and retrieval system. The microfiche format is a rectangular sheet of film containing document images arranged in regular rows and columns. The standard size for Federal Government applications is 4 by 6 inches, with 60 document images arranged in 5 rows of 12 images each. Each image is precisely positioned on the sheet of film, with frame centers a specified distance from each other in both height and width. This positioning can be obtained in one of two ways. First, the documents can be photographed on a narrow film, such as 35-mm width, and then cut into strips of 12 images each and pasted up on clear acetate to form the master fiche. Or the documents can be photographed on 105-mm film (4.1 inches wide) by means of a camera that will transport the film magazine in a step-and-repeat fashion until

it has sequenced through 5 rows of 12 frames before advancing the film another 6 inches.

Microfiche masters made by the method of compositing and pasting up narrower strips of film are called microfolio microfiche. Additional equipment is required to trim the strips to size and to coat the edges of the film with adhesive. An additional set of steps is required to paste up the original master fiche. The throughput time for materials prepared in this manner is longer. The step-and-repeat camera, which does the job of composition and placement as it exposes the master fiche, however, is significantly more expensive than a camera without this capability. The microfiche master produced by a step-and-repeat camera is called a unitized microfiche. The step-and-repeat capability is available on both rotary and planetary cameras, in a limited number of models.

c. Cost

While equipment costs are presented in detail in the appendix, it is worth noting that there is considerable difference between the costs of rotary and planetary cameras, and cameras of either type which have the step and repeat capability. The following table summarizes the ranges of these costs:

	Low	Average	High
Rotary Cameras	$ 500	$ 2,500	$ 3,900
Planetary Cameras	$1,000	$ 5,000	$12,000
Step-and-Repeat Cameras	$1,000	$25,000	$35,000

5. Film Processor

Once the film has been exposed, it must be processed so that the latent image on the raw negative film becomes visible. There are two stages in film processing, often referred to as the wet and the dry stages. In the wet stage, the exposed film is placed in a developing solution that converts the exposed silver halide in the emulsion to metallic silver and creates the image. The film is then rinsed to remove any traces of the developer and placed in a fixing bath. The fixing solution,

often referred to as hypo, removes the unexposed silver halide. The film is then placed in a final wash bath to remove any traces of hypo carried over from the fixing bath.

After the film is developed and fixed, it enters the drying stage. The timing and the temperature of the drying stage are important; if an infrared lamp or warm air blower is improperly used for drying, the surface of the film can become excessively dry while the body of the film is left with excessive moisture content. Improperly dried film does not retain archival permanence and cannot be used without being easily scratched and damaged.

Microfilm is processed the same way as conventional black and white film, except that the time intervals in the various developing stages, solution strengths and temperatures, and general handling techniques are far more critical than with conventional films. For large production systems, completely automated film processing equipment is required, as is test equipment for quality control. Spectrometers, densitometers, temperature gauges, oscilloscopes, and microscopes are required for positive quality assurance. Costs for fully automated processing equipment range from $2,000 to $50,000 or more. For smaller systems, semiautomatic equipment is available; however, skilled operators are required.

6. Reader

Once the original records are microfilmed, a reading device is required to complete a simple, basic system. A reader consists essentially of a microfilm holder, a lens system for enlargement of the image, a screen for viewing the enlarged image, and controls for focusing the image or for selecting a portion of the image and focusing.

Readers may be equipped to handle roll film only, aperture cards only, microfiche only, or any and all combinations of microforms. It should be noted, however, that there are only two devices commercially available that handle microopaques (microcards) and transparent microforms with the same reader, and, in fact, only three readers that handle microcards at all.

In terms of controls, readers may have fixed magnification ratios or variable magnification, variable illumination, and multiple focusing controls. The number of control features largely determines the cost of a reader. The least expensive readers cost about $2 and work like a hand slide viewer, using ambient light. These, of course, are impractical for any purpose other than the most cursory inspection. An average cost for a good, flexible, self-contained viewer is about $350.

7. Printer

The function of the printer is to provide enlarged hard copies of microimages for immediate use. By far the large majority of such devices are combined with readers, and are called reader-printers. The reader allows the user to inspect the microform before it is printed to be sure that he is getting what he desires. The printer records the image from the microform on paper stock and ejects the printed material. Paper stock may be in sheets or on rolls. Printers may be of the wet-process type, electrostatic, electrochemical, or dry-photo process.

The first successful reader-printer was not marketed until 1958. This delay was caused by technical problems, the solution of which then seemed to contradict conventional film printing methods. But when these problems were solved, an extremely versatile reader-printer was introduced, and it promptly changed the whole concept of microfilm applications for industrial use. The reader-printer, along with aperture cards, is primarily responsible for the current boom in microfilm activities. It has released microfilms from their passive role of storage and reference use by giving old microfilm systems the ability to provide enlarged, hard copies of microfacsimiles for instant use. Thus, active original records can be replaced by active microrecords, a feature that was impossible to attain prior to the introduction of reader-printers.

Reader-printers are quite simple to operate. The device is a self-sustaining unit that houses all the necessary reproducing equipment and material within a single shell. It is compact and highly automated, but

simple to operate. If the exposure setting is fairly accurate (the only aspect of a reader-printer requiring some knowledge or experience on the part of the user), the machine provides good, legible, dry copy--even in brightly lit rooms--at low cost.

To obtain an enlarged reference copy of the microimage, the image is sharply focused on the viewing screen, exposure time is set, and a button is pushed.

The print material may be paper suitable only for reference copies. Normal writing materials may be used on the paper. Or the paper may be suitable for printing techniques, including offset lithography. In general, the output from reader-printers is not itself reproducible. For volume reproduction, the microfilm may be used to generate a transparent copy, corresponding to a vellum master, which permits copies to be made on a diazo machine; or the microfilm may be used to make a plate for use on an offset press. These plates may range in size from 8-1/2 x 11 inches to 18 x 24 inches.

Still another printing option uses the electrostatic principle to make black on white prints on ordinary paper at speeds up to 20 linear feet per minute.

Reader-printers range in cost from $500 to about $5,000.

8. Film Store

The final element of the microfilm document storage and retrieval system is the film store. This is the storage unit for housing the working master file of reduced documents on microforms. Depending on the needs of the user, the film store can vary widely in both cost and sophistication. At the very least, the film store need be no more than a filing cabinet. It must, however, be designed to receive the microforms established as the storage medium for the system. This means that the filing trays must be of the correct size and designed to protect the film materials on which the documents are recorded. For larger files, motorized files are available. These are usually rotary files, which have the filing trays mounted on a ferris-wheel arrangement inside the cabinet. By pressing a button, the operator brings the correct tray to the

retrieval station. By storing microforms in trays of optimum size, the retrieval time is considerably lessened.

The most sophisticated of currently available film storage devices stores unit records in units containing 200,000 unit records each. Retrieval is fully automatic. By inserting an accession number into a keyboard, the correct microfiche or aperture card is retrieved in 6 to 0 seconds and positioned in a reader-printer, ready for immediate viewing and printing. This device is also available with a digital computer interface, such that retrieval instructions can be output directly from the computer to the film store without human intervention. The retrieved microforms can then be viewed either through the reader or remotely, through closed-circuit television. The cost of the film store ranges from about $100 dollars for the simple file cabinet to about $60,000 for the fully automatic store with computer interface.

IV. COMMERCIALLY AVAILABLE SYSTEMS

A. General

This section discusses implementation of a microfilm document storage and retrieval system, utilizing commercially available equipment. Three different approaches are discussed: aperture cards, microfiche, and microcards. Two different configurations are presented for both aperture cards and microfiche. Because of the relatively limited application of microcards and the narrow choice of equipment available, only one microcard configuration is shown.

Each section following is arranged in approximately the same manner. There is a narrative summary of the major system factors of interest, a set of exhibits showing data flow and products, and an equipment list. The equipments listed are not, in most cases, the only equipments available to fulfill the functions shown. No endorsement or recommendation is intended by the inclusion of an item of equipment in these lists; they are intended to be illustrative only. Equipment selection for an actual system should be preceded by detailed operations analysis and evaluation of operational requirements.

B. Aperture Card System

1. General Description

A microfilm aperture card is adapted from a standard EAM (electric accounting machine) data processing card. The aperture card is the same size as the EAM card (7-3/8 by 3-1/4 inches), but has a window cut into it in which a frame of microfilm[1] is mounted with pressure-sensitive tape. Examples of preprinted aperture cards appear in Exhibit 6. The aperture card can easily be indexed manually or by keypunching methods; keypunching is generally used.

Keypunching the aperture card and mounting the right microimage on the keypunched card take several operations. First, a worksheet that lists the information to be keypunched is prepared manually. Second, the information is keypunched onto standard EAM cards, and the keypunching is verified. Third, the information from the card is reproduced on cards with glassine inserts, and the keypunched information is printed along the top of the card. Fourth, the glassine insert used to protect and preserve the adhesive binding is removed, and the film is mounted in the card.

The cards can then be sorted, collated, copied, etc., in the same way as a standard EAM card. However, the EAM equipment is usually modified to remove contact brushes for the card fields in which the film is mounted to prevent damage to the film.

The most significant application of aperture cards to date has been for engineering drawings and reports. Aperture cards have been used effectively in cutting operating expenses and achieving substantial savings over other methods of duplicating and filing blueprints and engineering changes. Currently, aperture cards are required by many government agencies, particularly in defense applications. Specifications have been set for the size and quality of the microfilm and for the uniformity of the cards. The requirement for the use of aperture cards and the specifications have helped in the development of reliable, sophisticated

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[1] In this section, one 35mm frame per aperture card is assumed, but other techniques are available.

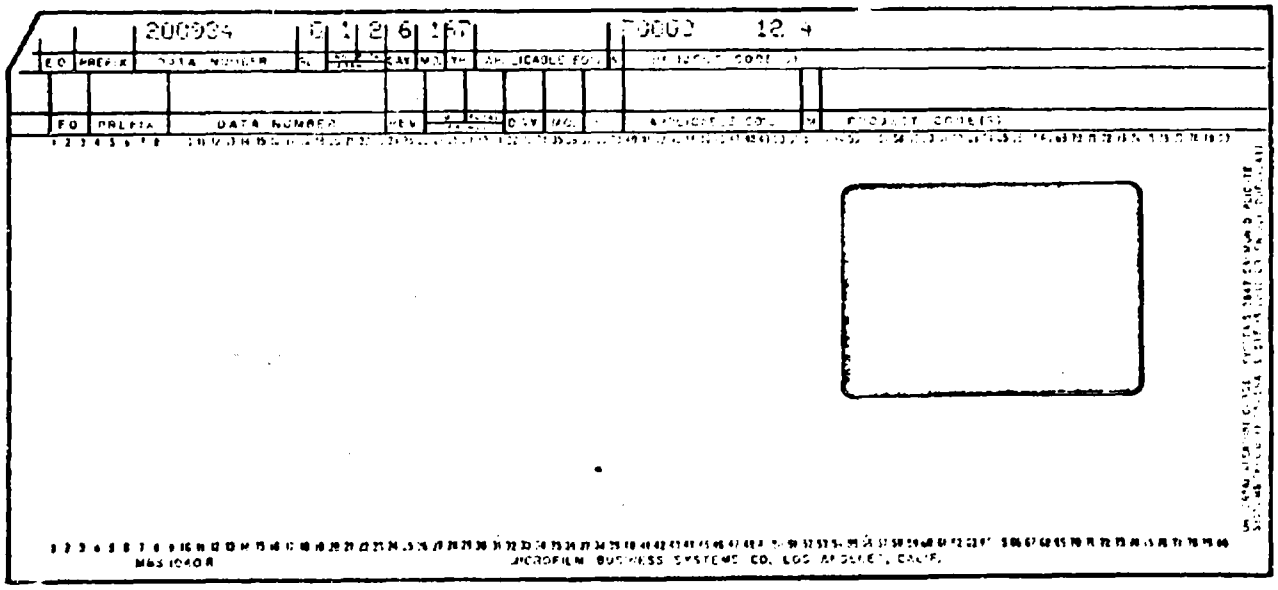

EXHIBIT 6 - PREPRINTED APERTURE CARD

equipment to produce the cards. Competition between manufacturers, suppliers, and service organizations has made available a wide selection of equipment in a broad range of purchase and rental prices.

An aperture card system can be made up of a complete line of associated equipment produced by one company or equipment purchased from different companies. Most systems are designed with the thought of acquiring precision equipment. This concept essentially eliminates the rotary camera, since precision work usually requires a planetary camera. Film processing units and related equipment are also purchased on a quality-first basis. Cost escalation for quality equipment is inevitable.

In Exhibits 7 through 10, two distinct aperture card systems are presented that show how costs can vary for the same microform. System A (detailed in Exhibits 7 and 8) is a complete system capable of precision microfilming and can be implemented for less than $5,000. The system uses a camera-processor which combines both functions in a single unit; it films the original documents, processes the film, and mounts the processed film in an aperture card, ready for use. Each completed aperture card costs approximately 7-1/2 cents. Duplicate cards, using the Uniprint copier, cost about 4 to 5 cents.

Exhibits 9 and 10 detail the flow and cost of basic aperture card system B. The basic cost of system B, $14,108.66, does not include the optional equipment listed in Exhibit 10 or any keypunching or data processing equipment. If the prices for such equipment were to be included, the cost of the complete system could exceed $50,000. The basic equipment listed in Exhibit 10 is adequate for any precision microfilming task and can produce microforms to meet military specifications.

2. System Capabilities and Limitations

The best way to describe the advantages of aperture cards is to make a direct comparison between the old techniques used for handling engineering drawings and the new techniques employed for the same procedures using aperture cards. This description of a typical application for aperture cards is not intended to restrict their use exclusively for engineering drawings and reports. The microfilm for this description

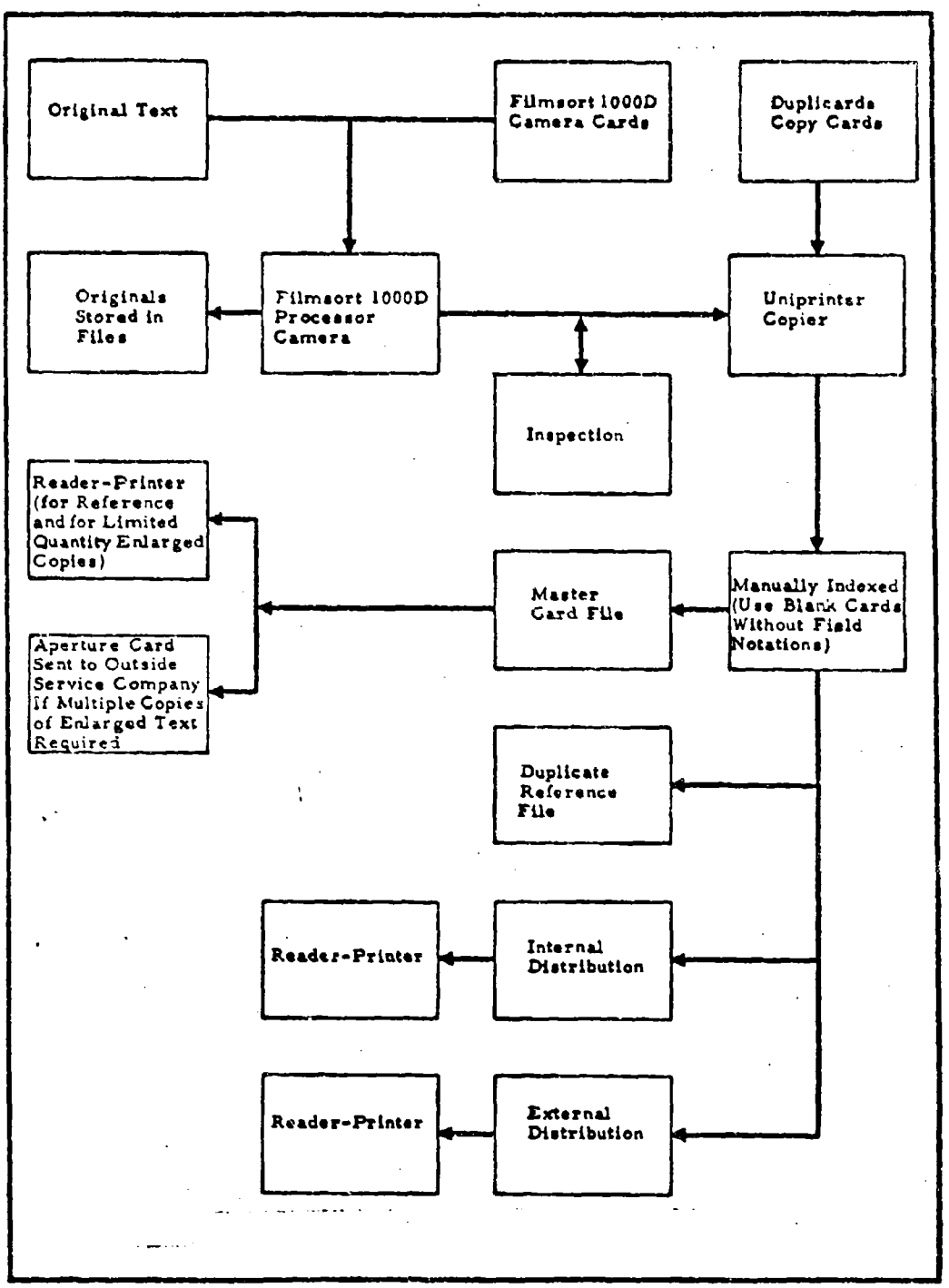

EXHIBIT 7 - APERTURE CARD SYSTEM A

EXHIBIT 8 - EQUIPMENT AND COSTS FOR BASIC APERTURE CARD SYSTEM A

Equipment	Specifications	Uses	Remarks	Price
Processor-Camera. Filmsort 1000D	1. Size: 28 x 37 x 33 inches 2. Weight: 400 lbs. 3. Electrical requirements: 110 volts, 14 amps.	Used to automatically film documents of the following sizes: a. One 18 x 24 inches b. Four 8-1/2 x 11 inches c. One legal size, both front and back.	1. Film in aperture card is exposed, developed, and ready to use in 54 seconds. 2. No technical training necessary to operate equipment.	$3,295.00
Filmsort 1000D Camera Cards	Standard EAM card Size: 7-3/8 x 3-1/4 inches	Used with the processor-camera	Price per 4 cartridges (500 cards in each cartridge).	124.00
Filmsort 1000D Developer		Used to develop exposed film	Packed in quart-size container.	1.50
Filmsort 1000D Fixer		Used to develop exposed film	Packed in quart-size container.	1.25
Uniprinter 086	1. Size: 17 x 12-1/2 x 17-1/2 inches 2. Weight: 60 lbs. 3. Electrical requirements: 110 volts, 3 amps.	Used to make duplicate copies of microfilm mounted in aperture cards onto diazo-type film in copy cards.	1. The Uniprinter has double development and exposure chambers that permit two operators to use the unit simultaneously	1,021.00

EXHIBIT 2 (Continued)

Equipment	Specifications	Uses	Remarks	Price
			2. The unit copies up to 300 cards per hour. 3. No technical training necessary to operate equipment.	
Duplicard Copy Cards	Standard EAM card Size: 7-3/8 x 3-1/4 inches	Used with the Uniprinter 086	Price per 2,000 copy cards	4.11
Developer		Used with Uniprinter 086	Packed in quart-size container.	1.55
Reader-Printer Filmac 200	1. Size: 32 x 31 x 36 inches 2. Weight: 200 lbs. 3. Size of viewing screen: 18 x 24 inches. 4. Print processing employed: electrochemical 5. Electrical requirements: 110 volts, 6 amps.	Used to view and/or print dry copies 17-1/2 x 24 inches in size. Also prints half-size copies 12 x 18 inches in size	1. Good quality enlargements can be made in approximately 6-1/2 seconds. 2. No technical training necessary to operate equipment.	1,285.00
Print Roll	Size: 18 inches x 237 feet (A roll 18 inches x 300 feet is also available at $35.21)	Used with Filmac 200 Reader-Printer.	Each roll contains 108 full-size prints at approximately 22 cents per print. (If	

EXHIBIT 8 (Continued)

Equipment	Specifications	Uses	Remarks	Price
Developer		Used with Filmac 200 Reader-Printer.	Approximate cost of chemicals is 1-1/4 cents per print.	$
(Optional) Reader-Printer Filmac 100	1. Size: 16 x 19 x 24-1/2 inches 2. Weight: 80 lbs. 3. Size of viewing screen: 7 x 9-1/4 inches 4. Print processing employed: electrochemical 5. Electrical requirements: 110 volts, 3 amps.	Used to view and/or print dry copies 8-1/2 x 11 inches in size. Image on print is 7 x 8-1/4 inches.	1. Good quality enlargement can be made in approximately 10 seconds. 2. Magnification ratio can be changed from 7X through 26X by changing lenses. Lenses priced at $66.50 each. 3. No technical training necessary.	729.00
Print Roll	Size: 8-1/2 inches x 298 feet	Used with Filmac 100 series reader-printer.	Each roll provides 300 full-letter-size prints at approximately 8 cents per print.	25.00
Developer		Used with Filmac 100 series reader-printer.	Approximate cost of chemicals is 1/3 cent per print.	100.00

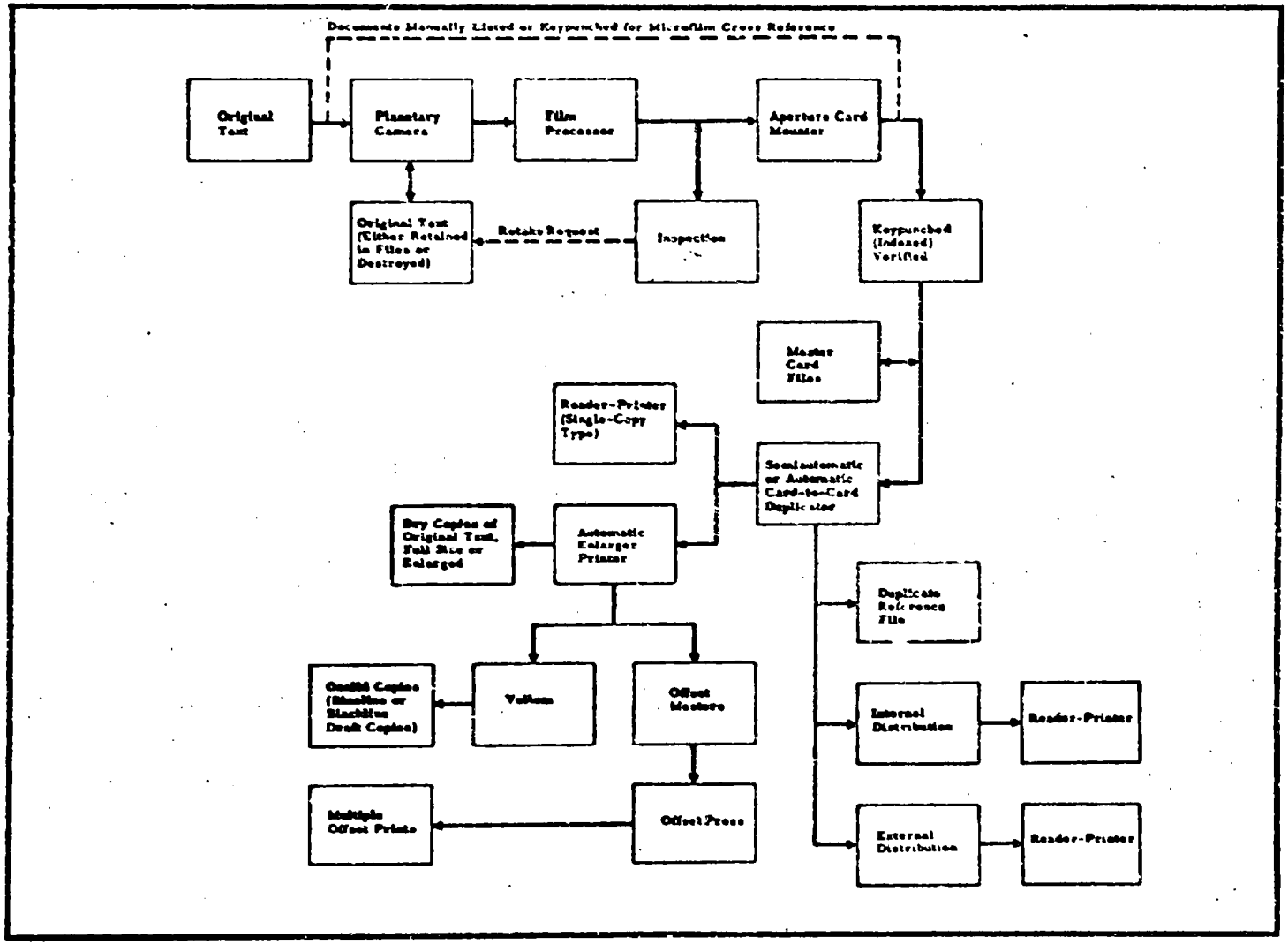

EXHIBIT 9 - APERTURE CARD SYSTEM B

EXHIBIT 10 - EQUIPMENT AND COSTS FOR BASIC APERTURE CARD SYSTEM B

Equipment	Specifications	Uses	Remarks	Price
Dea-Graph Model CA7 Planetary Camera (Dea-Graph Equipment Ltd., Canada)	1. Camera size: 12 x 10 x 6-1/2 feet 2. Weight: 800 lbs 3. Copyboard size: 38-1/2 x 55 inches 4. Automatic focus 5. Exposure speed 25 frames/min 6. Light meter and variable illumination controls 7. Adjustable copy table 8. Electrical requirements: 110 volts	1. Used to film documents and engineering drawings up to 37-1/2 x 52 inches 2. Unit can be converted to an enlarger by an interchangeable camera head (35 mm enlarger head optional at $1,150)	1. Makes continuous reductions from 6 to 30 diameters, with a guaranteed resolution of 120 lines per mm at 30X reduction 2. Film magazines are removable in a lighted room 3. Some technical training necessary to operate camera controls 4. Camera guaranteed to meet resolution requirements of MIL-M-9868, Dept. of Defense Microfilming Specifications	$4,750.00

EXHIBIT 10 (Continued)

Equipment	Specifications	Uses	Remarks	Price
Constant Voltage Transformer		Used to control line voltage fluctuations that can affect the density of microfilmed images		$ 400.00
Camera Curtains		Used to block extraneous light to maintain accurate illumination control		125.00
Film	35 mm panchromatic microfilm. 100-foot roll (a 100-foot roll has 580 to 2,320 frames, depending on the size of the original).	Commonly-used with aperture cards	1. 100-foot roll without processing is $5.50 (price reflects two rolls) 2. 100-foot roll with processing is $7.50	11.00
Duplicate Copy Cards	Standard EAM card size: 7-3/8 x 3-1/4 inches	Used with any duplicating machine listed in this table	Price per 2,000 copy cards	44.11
Developer		Used with Uniprinter 086	Packed in quart-size container	1.55
(Optional Automatic Card-to-Card Printer (mfr. 3M Company)	1. Size: 53 x 29 x 84 inches 2. Weight: 1,500 lbs. 3. Electrical requirements: 220 volts, 20 amps	Used to make duplicate copy cards from original aperture cards at the rate of 2,000 per hour	1. Used only for large-scale microfilming projects where	25,000.00

EXHIBIT 10 (Continued)

Equipment	Specifications	Uses	Remarks	Price
			multiple decks of aperture cards are needed for distribution to a number of locations 2. Fully automatic. No technical training necessary.	
Reader-Printer Filmac 200 (mfr. 3M Company)	1. Size: 32 x 31 x 36 inches 2. Weight: 300 lbs 3. Size of viewing screen: 18 x 24 inches 4. Print processing employed: Electrostatic 5. Electrical requirements: 110 volts, 6 amps	Used to view and/or print dry copies 17-1/2 x 24 inches in size. Also prints half-size copies 12 x 18 inches in size.	1. Good quality enlargement can be made in approximately 1-1/2 seconds 2. No technical training necessary to operate equipment	$1,176.00
Print Roll	Size: 18 inches x 237 feet (a roll 18 inches x 300 feet in size is also available at $35.21)	Used with Filmac 200 reader-printer	One roll gives 108 full-size prints at approximately 22 cents per print	28.06

EXHIBIT 10 (Continued)

Equipment	Specifications	Uses	Remarks	Price
Developer		Used with Filmac 200 reader-printer	Approximate cost of chemicals is 1-1/4 cent per print	$ 1.25
Film Processor Unio-pro F202 (distributed by Sperry Rand)	1. Size: 51 x 55 x 14 inches (requires 6 sq. ft. of space) 2. Weight: 168 lbs 3. Electrical requirements: 110 volts, 15 amps 4. Simple plumbing required	Used to automatically process 16, 35, or 77 mm films of up to 100 feet in length (200 ft. processing at extra cost)	1. Unit processes 100 feet of film in 30 minutes 2. Daylight loading 3. Some technical training required	2,275.00
Inspection Equipment (a) Microscope (mfr. Charles Bruning Co.)	50 power with substage illuminator	Used to read resolution targets	Required for rigid image control	160.00
(b) Densitometer. (distributed by Charles Bruning Co.)	1. Weight: 62 lbs. 2. Electrical requirements: 110 volts	Used to read negative density by photoelectric methods	1. Required for strict inspection requirements for government contracts 2. No special skill required	495.00

EXHIBIT 10 (Continued)

Equipment	Specifications	Uses	Remarks	Price
Semi-automatic Optical Card Mounter (mfr. 3M Company)	1. Viewing screen: 14 x 14 inches 2. Blower-cooled optical system 3. 8X magnification 4. Weight: approximately 100 lbs 5. Electrical requirements: 110 volts, 2 amps	Used to visually compare the image with the right aperture card (if aperture card was prepunched) and to automatically cut and mount the film onto the card	1. Microfilm can be verified and mounted at an average rate of 200 to 300 frames per hour 2. Unit is operated by pushbuttons	$4,071.00
Uniprinter 086 (mfr. 3M Company)	1. Size: 17 x 12-1/2 x 17-1/2 inches 2. Weight: 60 lbs 3. Electrical requirements: 110 volts, 3 amps	Used to make duplicate copies of microfilm mounted in aperture cards onto diazotype film in copy cards	1. The Uniprinter has double developing and exposure chambers that permit two operators to use the unit simultaneously 2. The unit copies up to 300 cards per hour 3. No technical training necessary to operate equipment	1,000.00
(Optional) Enlarged Hard-Copy Reproducing Machine: Xerox 1824 printer (mfr. Xerox Corp.)	1. Size: 65 x 32 x 32 inches 2. Weight: 600 lbs 3. Fixed 14.5X magnification (12X optional at extra cost)	Used to print enlarged copies on ordinary paper, vellum, or offset master material	1. Exposure, development, and delivery of prints are entirely automatic	15,000.00 or basic monthly rental up to 200 copies: $165.00

EXHIBIT 10 (Continued)

Equipment	Specifications	Uses	Remarks	Price
	4. Electrical requirements: 120 volts, 22 amps 5. Unit handles paper sizes from 8-1/2 x 11 inches to 18 x 24 inches 6. Print processing employed: electrostatic		2. Prints emerge dry, ready for immediate use in 21 to 30 seconds 3. Pencils or pens may be used on prints 4. Universal input to take roll film, aperture cards, or jacket films is available at extra cost	Unit copy charte over 2,000 copies: $0.02 per copy
(Optional) Enlarged Hard-Copy Reducing Machine: Bruning Copytron Model 1000 (mfr. Charles Bruning Co.)	1. Size: 43 x 79-1/2 x 53 inches 2. Weight: 875 lbs 3. Magnification: from 14X to 16X 4. Electrical requirements: 115 volts, 23 amps 5. Unit handles paper sizes from 8-1/2 x 11 inches to 18 x 24 inches 6. Print processing employed: electrostatic	Used to print enlarged copies on ordinary paper, vellum, or offset master material	1. Entire operation is automatic 2. Production rate is approximately 4 to 6 dry copies per minute 3. Pencils or pens may be used on prints 4. Accommodates 35 mm rollfilm or aperture cards	9,750.00

is a picture of an engineering drawing, but the picture can be readily replaced by other images such as technical reports, specifications, personnel records, business records, or other documents.

a. Size

There are 13 standard sizes of engineering drawings, ranging from 8-1/2 by 11 inches to 42-inch rolls. Drawings up to 36 by 49 inches can be reproduced on a 35mm frame 1-3/8 by 1-7/8 inches. This size includes almost 90 percent of all engineering drawings currently in use. Thus, most drawings can be converted into one standard size and shape. Because of the compact size, all the records can be housed in only 4 percent of the previous space requirements.

b. Duplication

Duplication of engineering drawings by blueprint or the diazo process takes a long time, especially when a requisition slip must be completed. Aperture cards, complete with film, can be readily reproduced by a Uniprinter that creates duplicate cards for reference purposes in a few seconds. Requisition slips can be eliminated.

c. Decentralized Files

Many companies can only affort one centralized location for filing and retrieving blueprints. With aperture cards, decentralized files may be feasible because the cards can be reproduced any number of times at low cost (approximately 4-1/2 cents per card), and a complete file takes up only 4 percent of the space required for blueprints. Decentralized files not only provide faster and easier reference points, but also add to the protection against loss of any vital documents and records.

d. Filing and Retrieving

Because of the large size of engineering drawings, elaborate shelves and filing bins are necessary for the central file. Retrieving a particular drawing from thousands of odd-size prints is a time-consuming and often frustrating task. Neat, compact, and uniform aperture cards can be easily indexed, filed, and retrieved within seconds after the initial request.

e. Reference

When an engineering drawing is checked out of the central file for active reference or use, the file is no longer completely intact. If someone else wants the same print for reference purposes, he must put in a request for a duplicate print to be reproduced from the original drawing or wait for the file copy to return. An aperture card never has to be removed from the active file area. By utilizing a reader-printer machine, the image can be magnified on the reader screen for reference purposes, or an enlarged print, ready to use, can be obtained from the reader-printer by merely pushing a button. The size of the enlarged print varies according to the type of reader-printer employed. An 8-1/2-by-11-inch print costs 7 cents; an 18-by-24-inch print costs 22 cents.

f. Data Dispersal

Bulky engineering drawings are hard to package and expensive to mail to outside distribution points. With approximately 105 aperture cards to the file inch, it is cheaper to airmail 105 aperture cards, containing the equivalent of 105 engineering drawings, than it is to mail the prints by parcel post.

g. Mechanization

By mounting the microfilm on an aperture card, the card can be reproduced, interpreted, collated, and sorted by IBM equipment. This eliminates the manual process of cutting, marking, folding, and distributing large blueprints.

Aperture card systems are now used by many organizations because of their advantages over conventional paper-handling techniques; like most other systems, they are not without weak points. The following limitations are inherent in an aperture card system for engineering drawings:

1. Engineering drawings over 36 by 48 inches cannot be filmed on a 35mm frame. Larger films, such as 70mm and 105mm, must be used to accommodate large drawings. If 35mm film is used, larger drawings must be sectionalized or cut, and more than one aperture card must be used for a single drawing. Often, large-size blueprints are not recorded, but left "as is" when an aperture card system is implemented.

2. Aperture cards cannot be used for simultaneous, large-scale reference work. If an engineering group must spread a series of past, present, and proposed drawings over a table together with accompanying pages of specifications to compare them, a reader-printer is inadequate to cope with such a situation. The originals must be supplied, or some other methods must be devised for such occurrences.

3. Transcription errors can occur in source documents for aperture cards and in keypunching. Information to be keypunched is usually entered on worksheets by hand-posting. These manual listings are extremely vulnerable to transcription errors. Extra care must be taken and manual verification checks must be made to avoid transcription errors. Normal verification of the keypunching is also required.

4. Aperture cards cost about 40 times as much as standard EAM cards. Extreme care must be taken in keypunching, verifying, and interpreting cards with glassine envelopes to avoid damaging the card. The data processing equipment used may have to be modified to reduce potential card loss. The aperture card with the microfilm mounted is less subject to damage in sorting, listing, and computer entry operations than is the aperture card with glassine insert during the keypunching phase. However, the aperture card is more easily damaged than the standard card without insert during all phases of operation.

3. Personnel and Training Requirements

Personnel and training requirements differ with the type of aperture card system to be implemented. If system A is used, no technical training is required because of the high degree of automation incorporated in the Filmcort Processor-Camera. The only real training required of the operator is reading the instruction manual that comes with the camera and gaining familiarization with some of the equipment controls before trying to operate the camera.

If system B is used, a great deal of technical training is required before the planetary camera can be operated efficiently. Also, some general background knowledge of microfilms and their processing techniques is required, in addition to a great deal of practical operating

experience. Additional microfilming personnel and a separate microfilming department, although not necessary in a small-scale operation, might be required to sustain a precision microfilming unit.

C. Microfiche System

1. General Description

The French word "microfiche" has come to describe a translucent sheet of film containing microimages. Introduced into the United States in 1962, the microfiche has an initial advantage over roll microfilm for many applications by its index-card presentation and form. Shown in Exhibit 11 is the 4-by-6-inch microfiche, recently adopted as the standard size by DDC, NASA, and AEC. Each small image on the microfiche was originally a letter-size page. One 4-by-6-inch microfiche contains approximately 60 miniaturized pages. The microfiche can be used for reading the document and making photographic positive or negative copies for additional distribution.

In April 1963, NASA and AEC agreed to develop identical standards for reduction ratios and frame spacing in their microfiche. In addition, the Federal Council for Science and Technology directed all executive agencies to adapt the microfiche method for their reports. During the first 6 months of 1964, increasing acceptance of NASA's microfiche by other Government agencies resulted in further standardization of its size and format. These developments paved the way for commercial suppliers to concentrate on simple, more efficient, and less costly designs of equipment to produce microfiche.

a. Standard Sizes

A microfiche standard for documents 8-1/2 by 11 inches or smaller has been established by the National Microfilm Association (NMA). The NMA standard identifies four acceptable microfiche sizes: 75 by 125mm, 105 by 148mm, 5 by 8 inches, and 3.25 by 7.375 inches. A reduction ratio of 18:1 to 20:1 is specified with a fixed frame size. It was announced that all Government agencies would standardize with the 105 by 148mm size (approximately 4 by 6 inches) early in 1965.

Previously, most European users had standardized on the same size. Other sizes are in use, including 3 by 5 inches (standard library card size), 3-1/4 by 7-3/8 inches (EAM card size), and 5 by 8 inches (report size).

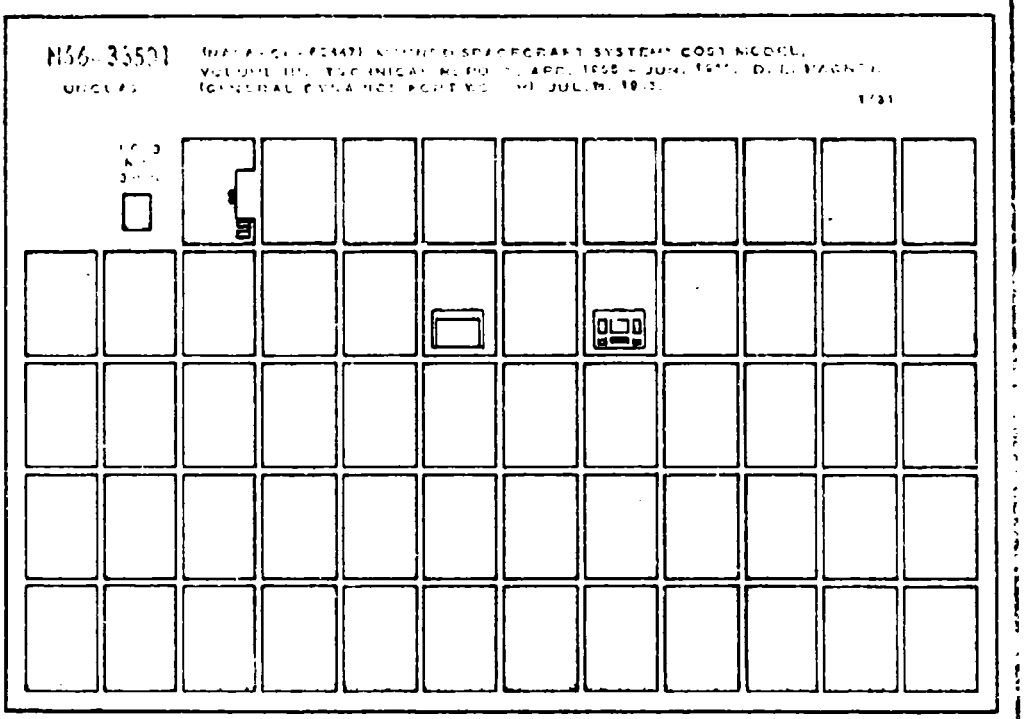

EXHIBIT II - "ATS 4-D1-6 INCH MICROFICHE"

The 4-by-6-inch microfiche usually has 60 images, arranged in 5 rows of 12 images each. NASA is using an 18:1 reduction ratio, with the 60 images. Three of the 60 images are used for eye-legible information.

The 5-by-8-inch microfiche usually holds 60 to 72 images, depending on whether 5 or 6 rows of 12 images each are used. Most technical reports can be contained on one microfiche.

The 3-by-5-inch size was widely used in early microfiche applications. It holds approximately 40 to 50 pages, depending on the format and reduction ratio used. Studies indicate that less than 60 percent of the technical reports can fit on one 3-by-5-inch microfiche.

The tabulating card size microfiche is used in some commercial applications, and experimentally in a small number of military applications.

b. Format

Nearly all microfiche cards are composed of two fundamental parts. They are as follows.

(1) Heading

This is a description of the document and may contain the publisher's name, title, author, classification, and identifying numbers. Located at the top of the card, this information is readable with the naked eye.

Two types of headings are used. The most common heading consists of information running the full width of the microfiche. Classification or identifying numbers are found in either top corner or in both. To simplify page location, the heading usually contains the page numbers found on that microfiche and the number of microfiche found in that particular set. Accurate and descriptive information is essential to easy location of material.

The full-width heading is usually produced as a separate item in the process of making the original negative. The heading and the microtext are processed separately and then taped together on one mask--a process called stripping. The stripped negative is the master from which all copies are made.

Another method of producing the heading eliminates the stripping process and makes the heading one or several of the first few frames. Letters 1 to 1-1/2 inches are usually used in the heading mockup during filming operations. When reduced to the microframe size, they are still legible to the naked eye.

Additional labor for the stripping operation is not required in this system, and the negatives are easier to maintain and use when they are in one piece. Unitized negatives of this type are often kept in a roll to facilitate high-speed printing of additional copies.

(2) Microtext

In a microfiche, the pages are normally in sequence in rows beginning with the upper left-hand corner and reading from left to right. Occasionally, pages will run in columns from top to bottom instead of in rows, but this sequence is generally reserved for special applications.

c. Types of Microfiche

(1) Microfolio Microfiche

The microfolio system requires the application of an adhesive tape to the edges of a roll of microfilm. Special equipment automatically lays the strips of microfilm on a sheet of acetate in a predetermined order. This is called the microfiche master, and, since it is composed of silver film, it is desirable to make a diazo copy of the master microfiche.

(2) Unitized Microfiche

The unitized system uses roll film in making a microfiche, but the width of the film is not 16 or 35mm; it is 105mm--approximately 4 inches. A step-and-repeat camera is used to capture some 60 images in a precise grid pattern directly onto the 105mm film that will accommodate 200 microfiche, each 148mm long (approximately 6 inches).

d. Photographic Techniques and Titling

The planetary camera uses standard 35-mm roll film. After processing, the excess microfilm is slit away (usually while it is still in roll form), the film is cut into strips of 14 (or less) images, and the strips (6 or less) are mounted in a supporting acetate frame. The completed frame is the master microfiche negative from which an intermediate diazo duplicate master is made. This duplicate master is then used to produce subsequent duplicates. This procedure produces microfolio microfiche.

A special title camera is used to photograph identifying information for each microfiche, and this information can be read without enlargement because it is provided at normal size.

When the step-and-repeat camera is used for the microfiche, the upper portion of the 3-by-5-inch film is left unexposed. The title information is photographed with the title camera on the unexposed portion of the microfiche. When the planetary camera is used, the title camera is operated independently to produce a film strip with the readable material for mounting in the mast microfiche frame.

After the title is filmed and becomes a part of the microfiche master, a white opaque material is applied to the back of the title block to facilitate reading. This opaque material can be applied by a hot-stamp machine or by silk-screen techniques.

The camera automatically positions the film after each exposure to give the desired image size and separation between each set of images (left- and right-hand pages considered as a set), and to position these sets in the desired combination of rows and columns. Either vertically or horizontally oriented formats are used.

e. Basic Microfiche Systems

Exhibit 12 shows a basic microfiche system. Either a planetary or step-and-repeat camera can be used; both have been shown for convenience. Exhibit 13 provides a description of typical equipment for microfiche applications. Other planetary cameras, processors, and reader-printers are commercially available. No implications of superiority for the listed equipment are intended. There is a smaller selection

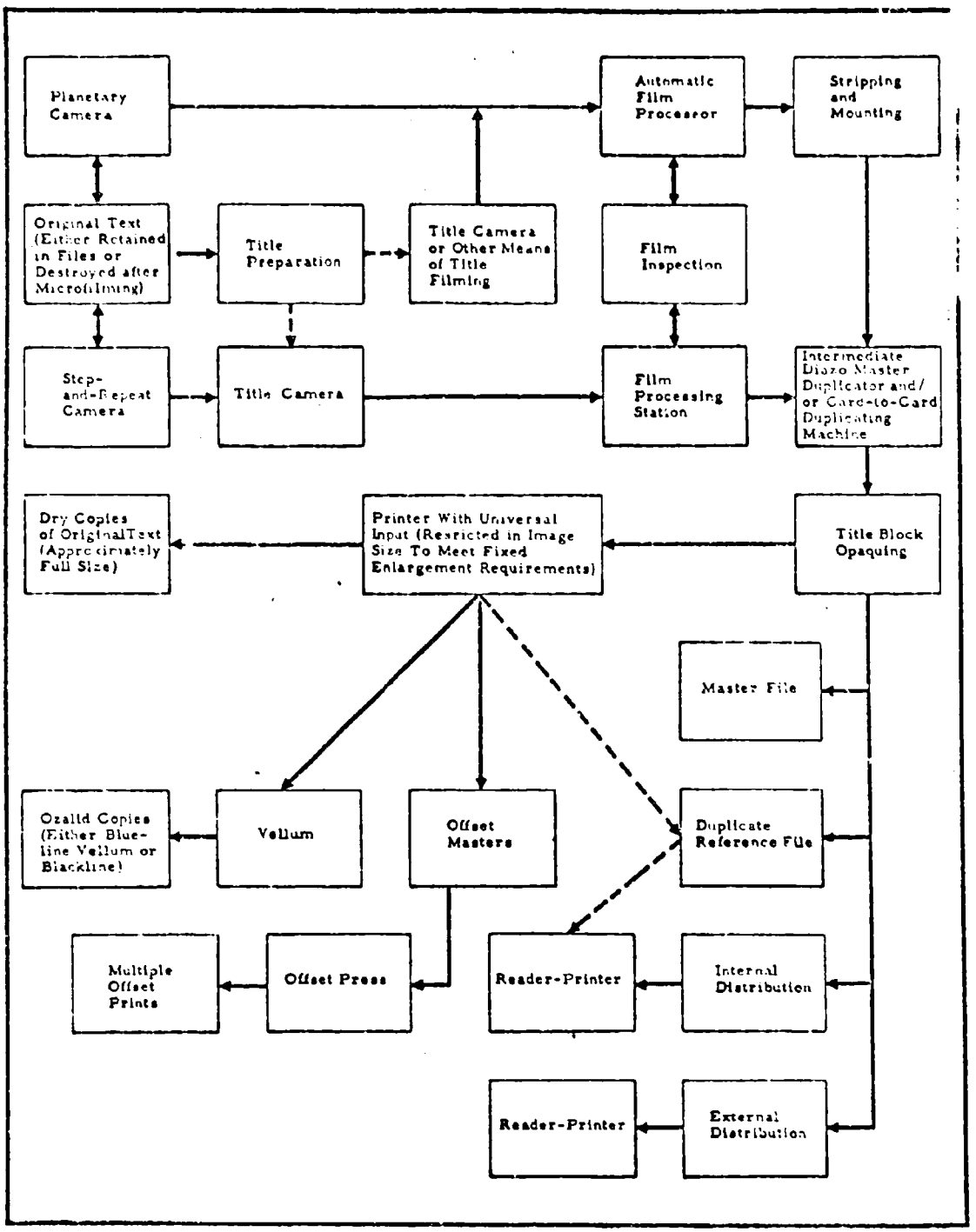

EXHIBIT 12 - MICROFICHE DOCUMENT STORAGE AND RETRIEVAL SYSTEM

EXHIBIT 13 - EQUIPMENT FOR MICROFICHE SYSTEMS

Step-and-Repeat Cameras (Rotary Cameras)

Equipment	Specifications	Use	Remarks	Price
Dagmar Automatic Step-and-Repeat Microfiche Camera Outfit Outfit also includes title camera, semiautomatic printer, static table, and complete developing equipment and supplies. (Distributed by Audio Visual Research Corporation.)	1. Camera size: 6 x 3-1/2 x 3-1/2 feet 2. Weight: 150 lbs 3. Maximum copy size: 16 x 24 inches 4. Voltage regulation within 5 percent 5. Electric timer and automatic film control 6. Electrical requirements: 115 volts	Used for filming documents and books on 9 x 12 cm sheet film (all documents and books are photographed under glass)	1. Makes continuous reduction from 10 to 28 diameters 2. One control button opens shutter, initiates electronic timer, and moves microfiche holder to next filming position 3. The number of frames per one microfiche negative can be varied from 8 to 80. Format can be varied from 2 lines of 4 frames to 8 lines of 16 frames per microfiche.	$3,795.00 (Complete outfit)
Microcard/SR-1	1. NMA format 2. Automatic cycling 3. 105 mm film 4. 16 x 23 mm frame		1. Locater panel shows camera position at all times 2. Produces unitized microfiche	$28,000.00
Photo Devices/ PD-1342	1. 105 mm film 2. Image-to-image accuracy within 0.005 inches		1. 10X to 26X reduction 2. Produces unitized microfiche	$35,000.00

EXHIBIT 13 (Continued)

Planetary Cameras

Equipment	Specifications	Use	Remarks	Price
Recordak Microfile Planetary Camera, Model MRC-4 (Mfr. Recordak Corporation)	1. Camera size: 10-1/3 x 8 x 4 feet deep 2. Weight: approximately 800 lbs. 3. Copyboard size: 37-1/2 x 52-1/2 inches 4. Automatic warning devices 5. Light meter and variable illumination controls 6. Automatic focus 7. Curved vacuum platen 8. Electrical requirements: 100 to 125 volts	Used for precision filming of documents and engineering drawings	1. Makes continuous reductions from 12 to 30 diameters 2. Can be used to standardize the microimage size regardless of the differences in original text size 3. Some technical skills are necessary to operate camera controls 4. Camera meets MILSPEC resolution requirements	$5,150.00
Recordak MRD-2	1. 16 or 35 mm film 2. NMA format 3. Automatic focusing 4. Accepts data 26-1/4 x 36-3/4 inches in size	Produces microfolio microfiche	1. Medium-volume planetary 2. 5X to 21X reduction	Not available

EXHIBIT 13 (Continued)

Planetary Cameras (Continued)

Equipment	Specifications	Use	Remarks	Price
Itek IBP 1400	1. Variable focus 2. NMA accepted	Produces microfolio microfiche	1. Medium-volume planetary 2. Variable reduction ratio	Not available
Photo Devices PD 1400	1. Uses 16 or 35 mm film 2. NMA accepted	Produces microfolio microfiche	1. Medium-volume planetary 2. Continuously variable reduction ratio 12 through 20	$2,400.00

Processors

Filmflow Processor (Distributed by Microdealers Inc.)	1. Size: 48 x 48 x 24 inches (requires 8 sq. ft. of space) 2. Weight: 250 lbs 3. Buzzer alarm and light signal warning devices 4. Electrical requirements: 110-115 volts	Used to automatically process 16- or 35-mm roll film of up to 100 feet (200- and 1,000-foot optional accessories are available)	1. Unit automatically processes 100 feet of film in 20 minutes 2. No permanent plumbing connections on floor drains are necessary 3. Has automatic safety controls to ensure quality processing 4. Can be loaded in daylight 5. Can be operated by nontechnical personnel	Not available

EXHIBIT 13 (Continued)

Contact Printers

Equipment	Specifications	Use	Remarks	Price
Microline Sheet Film Duplicator (Distributed by General Aniline and Film Corporation)	1. Size: 28-1/4 x 33-1/8 x 24-1/2 inches 2. Weight: 420 lbs 3. Printing widths: two 9-inch tracks 4. Anhydrous ammonia developer system 5. Electrical requirements: 220 volts	Used to make direct negative-to-negative (or positive-to-positive) copies of sheet films	1. Duplicator combines exposure and development in one unit 2. Two duplicates can be made simultaneously 3. Duplicates are delivered and stacked in sequence to facilitate collating	$5,400.00
KALVAR/K-10	1. Semiautomatic vacuum frame printer 2. Uses 400-watt mercury vapor lamp	High-speed copy film printer	1. High resolution	$895.00
Itek IBP 302	1. Prints copy film at 90 feet per min 2. Uniform film advance		Absolute contact. Controlled illumination.	Not available

Microfilm Readers

Microfiche Reader (Mfr. Dukane Corporation)	1. Size: 19 x 13 x 15 inches 2. Weight: approximately 15 lbs	Used as a compact desk-top reader (requires only 1 sq. ft. of space)	1. Reader can be used under normal office lighting conditions	$198.00

EXHIBIT 13 (Continued)

Microfilm Readers (Continued)

Equipment	Specifications	Use	Remarks	Price
	3. Size of viewing screen: 12 x 10-1/2 inches 4. 15X magnification 5. Electrical requirements: 6-volt battery		2. Accommodates microfiche up to 5 x 8 inches	
Remington F446			Maximum size 105 mm x 148 mm	Not available
Bell and Howell EF1			Maximum size 105 mm x 148 mm	Not available
Dukane 5Y6			Maximum size 105 mm x 148 mm	$250.00
Recordak PFC 46			Maximum size 105 mm x 148 mm	Not available
Documat 200			Several variations available	$456.00
Microcard Micro III			Portable, reads microcard and microfiche	Not available
Microcard Mark IV			Designed for use with new NMA format	$350.00
Griscombe KL-58				Not available

EXHIBIT 13 (Continued)

Microfilm Readers (Continued)

Equipment	Specifications	Use	Remarks	Price
Griscombe KL-46			Maximum size 105 mm x 148 mm	Not available
Recordak PKL-58				Not available
Recordak PKL-46			Maximum size 105 mm x 148 mm	Not available
Remington F458				
Microfiche Hard-Copy Enlargers				
EL-3 Microcard(1)			High-volume 5,000 to 25,000 pages/day range; step-and-repeat; automatic; silver; designed for NMA format	Not available
Xerox 1824			Manual operation; 500 to 2,000 pages/day range	Not available
Itek 1014			Manual operation; 2,000 pages/day range	Not available

Note: (1) Available on service bureau basis only. For on-site production operated by Microcard Corporation.

EXHIBIT 13 (Continued)

Microfiche Reader Printer

Equipment	Specifications	Use	Remarks	Price
Microfiche Reader-Printer Model 300A (Mfr. Documat, Inc.)	1. Size: 26 x 13 x 30 inches 2. Weight: 70 lbs 3. Size of viewing screen: 11 x 11 inches, ground glass 4. Print processing employed: stabilization 5. Electrical requirements: 110 volts	Used to view and/or print (either manually or automatically) dry copies 8-1/2 x 11 inches in size. Film image is 7 x 9-1/4 inches.	1. Automatic step-and-print features are incorporated in unit. A selected image or an entire line can be automatically viewed (one image at a time) and/or printed and delivered in proper sequence. 2. Print processing takes 25 seconds 3. No technical training is necessary to operate automatic features	$1,495.00
Polydex/M-16A		Microfiche	Electrostatic	Not available
GM: 100MF 200R 300		Microfiche	Electrolytic	Not available
Recordak Magnaprint		Microfiche	Silver halide	Not available
Documat Mark II		Microfiche	Silver halide	$920.00
Itek 1824		Microfiche	Silver halide	$2,845.00

of step-and-repeat cameras, film duplicators, and hard-copy reproduction equipment. Most of the step-and-repeat cameras must be imported.

The appendix shows all the equipment available for the implementation of microfiche systems.

2. Methods of Producing Microfiche

a. Microfolio Microfiche Method

In Exhibit 14, the equipment necessary for the microfolio microfiche method is identified. Documents are filmed on a planetary microfilm camera. This is a variable-focus camera, using 35mm film. The film is unperforated and comes in a daylight loading cartridge.

The exposed film is developed in a silver film processor which processes any length, from a complete roll to a 2-foot strip. The processor automatically does the complete job of developing, fixing, washing, and drying. No darkroom is required.

The developed microfilm is then processed through the microfolio applicator. This unit trims away excess film and applies a crystal clear, special adhesive to the outer edges of the film roll. The time required for this phase is 3 minutes per 100-foot roll of either 16 or 35mm film.

The roll is then routed to the film mounter, which removes the vinyl protective backing from the adhesive and automatically advances the film for mounting on 4-by-6 inch acetate sheets.

The product from the film mounter is a microfiche master (the silver film mounted on a 4-by-6-inch sheet of acetate). The microfiche master goes to a diazo printer for producing microfiche reference copies on a demand basis. Reproduction copies are completely dry, of good resolution and inexpensive. The master can then be immediately returned to its file.

Hard copies are generated from an offset master, which can be produced on a printer such as the Xerox 1824.

The microfolio master microfiche can provide any number of exact, completely dry, duplicate copies, quickly and inexpensively, without ever leaving the record filing area. This unique feature eliminates the problem of "incomplete" or "unavailable" records. Copies can be retained indefinitely or destroyed.

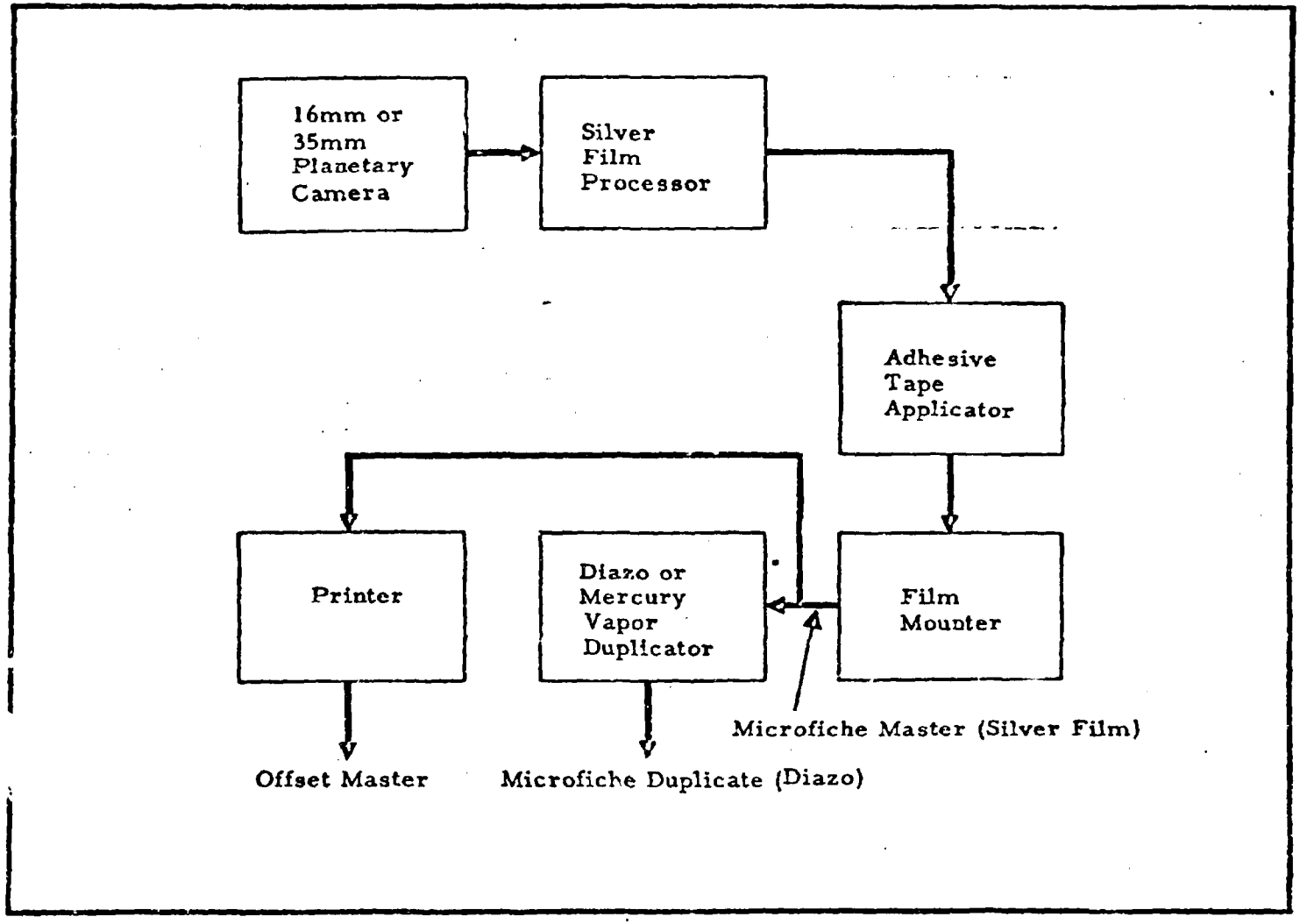

EXHIBIT 14 - MICROFOLIO MICROFICHE PRODUCTION

The microfolio microfiche method is very flexible and is the least expensive of the microfiche methods. The system allows for additions or deletions of images, thereby ensuring the capability of updating any particular information at all times.

b. Unitized Microfiche Method

In Exhibit 15 the equipment used and product generated by the unitized microfiche method are identified:

(1) Documents are filmed on a step-and-repeat camera. This camera utilizes a 100-foot roll of 105-mm film and produces, depending upon the make and model used, approximately 200 unitized microfiche negatives per roll at an 18 x reduction. These microfiche cards are 4 by 6 inches in size and have a maximum capacity of 60 images.[1] They are made to the standard adopted by the National Microfilm Association for technical reports.

The step-and repeat camera utilizes an accompanying console which controls the camera and shows the operator the frame being processed. The camera also includes an automatic integral titler which reproduces the report title, accession number, etc., at the top of the microfiche.

After the 100-foot roll of film has been exposed, the roll of silver film is removed from the camera and developed. The result is a roll of silver film containing approximately 200 negative microfiche.

(2) This roll of silver film becomes the master negative. Duplicate diazo film microfiche cards are printed for immediate distribution. A diazo working master is also printed, from which duplicate microfiche copies and enlarged copies can be made in the future. In the case of reports submitted on microfiche, such as from AEC or NASA, the microfiche received becomes the working master.

Once duplicate diazo rolls have been printed, the silver master negative is stored and not used again unless it becomes necessary to produce a new working master. The rolls, including the working master,

[1] When more than one microfiche is required to reproduce a document, "trailer" fiche cards with a maximum capacity of 72 pages each are us

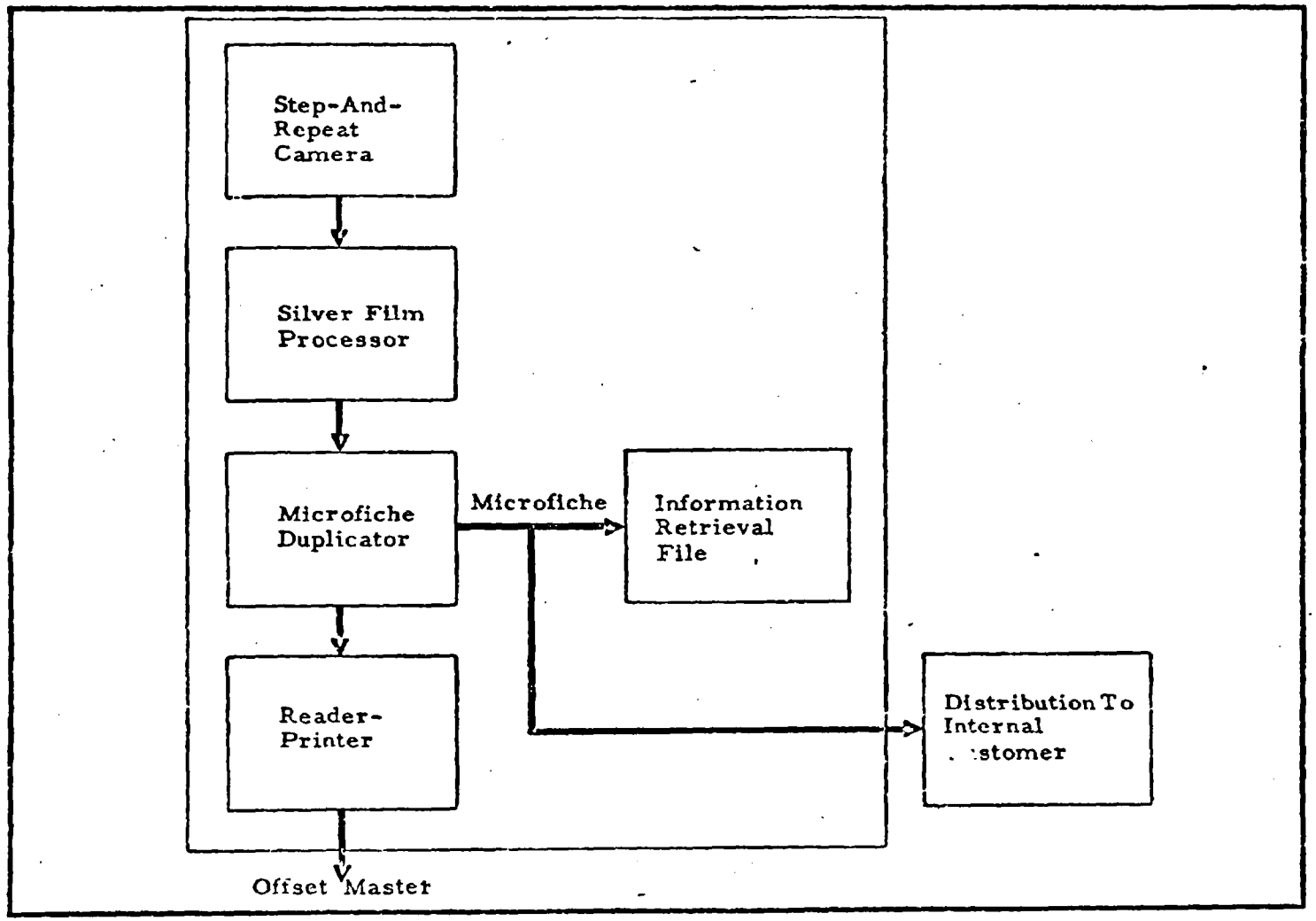

EXHIBIT 15 - UNITIZED MICROFICHE PRODUCTION

are cut on an automatic cutter into individual microfiche cards, which are then microscopically inspected for imperfections. The result is one fiche per report, except in cases of long reports requiring trailer microfiche.

(3) Enlarged copies of hard-copy reports are supplied through use of a step-and-repeat enlarger, a machine which has a 25,000-page-per-day capacity.

When an enlarged copy of a report is required, the working master is pulled from the appropriate file and inserted in a grid or fiche holder. The grid and the programming slip for the microfiche are placed in the step-and-repeat enlarger. As the grid automatically cycles so that one frame after another is exposed at a rate of 3,000 pages per hour, a photoelectric cell scans the programming slip for automatic adjustment of exposure for halftones, etc., and for automatic shutoff after the last frame is processed. Documents are normally printed out at 60 percent of their original size; however, 8-1/2-by-11-inch reports can also be produced.

The 500-foot exposed roll of silver base paper produced by the step-and-repeat enlarger is subsequently routed to a processor such as the Kodak Ektaline 200, which processes at a rate of 24,000 pages per hour, and is then cut on an automatic cutter. The resulting sheets are stapled between covers and the report is ready for distribution.

(4) If the request is for a microfiche copy rather than hard copy, the working master is pulled from the file and a duplicate diazo copy is made.

Thus, one microfiche working master negative answers three requirements--initial distribution to standing orders, microfiche distribution to fill incoming orders, and hard-copy distribution to fill incoming orders. In addition, the working microfiche master provides high-density storage: 100 fiche cards (6,000 pages) can be filed in a linear inch of drawer space. Shipping charges are minimal. An unclassified microfiche, containing a 60-page report, can be mailed for 5 cents.

3. A Case Summary

The General Electric Company did a study of microfiche systems, with the view of providing a substantial improvement in the technical

publications components of two major corporate technical departments. The manufacturers of equipment considered most appropriate to GE's needs included Microcard Corporation, Itek Corporation, Bell and Howell, Recordak Corporation, and Kalvar Corporation.

The following equipment and labor estimates are approximate costs estimated to be within 10 percent of actual costs. The costs are given in this manner so that nearly all manufacturers' equipments are included in the representative systems.

The cost savings with respect to filing derived by the use of either microfiche system are considered the same, making it unnecessary to include costs for files in the following system costs:

Microfolio Microfiche System	Purchase and Lease Costs
Including: roll film camera, silver film developer, tape applicator, mounter microfiche duplicator, and hard-copy reader-printer	$ 6,000
Labor costs per year (4 people)[1]	20,000
Total	$26,000

Unitized Microfiche System	Purchase and Lease Costs
Including: step-and-repeat camera, silver film developer, automatic cutter, microfiche duplicator, step-and-repeat enlarger, hard-copy developer, and plate maker	$ 7,500
Labor costs per year (2.1 people)[1]	14,000
Total	$21,500

Reader for Engineering Usage	
Portable (microcard)	$150 each
Stationary (Bell and Howell and other)	$300 to $500 each

The specific recommendations of the GE study were as follows:

1. Allocate approximately 1,000 square feet of work space, as listed below, with restricted area access for the purpose of establishing

[1]Labor estimates were based on the assumption that the microfilming capability would be part of the existing Technical Publications Component.

a · ofiche capability in RSD. This area will require plumbing, 220-V electrical service, and air conditioning at 70° F.

	Floor Space (sq. ft.)
Camera	50
Developer	50
Film Cutter	30
Files	20
Storage Area	35
Desk Space	120
Copy Machine	25
Retrieval Files	25
Reader's and Researching Area	650
Reader-Printer	100

2. Implement the microfolio microfiche method immediately through lease and purchase of the required microfilming equipment for a 6-month pilot run. Estimated total costs are as follows:

Equipment	Purchase (dollars)	Lease (dollars)
Camera, Recordak MRD-2 with 16 mm Adapter		115/month
Silver Film Processor		95/month
Tape Applicator		75/month
Mounter		60/month
Colite Fiche Duplicator[1]	745	
Kalvar Developer[1]	285	
Xerox 1824 Printer[1]		205/month
Documat Reader-Printer[1]	995	
Microcard FR-5 Reader[1] (6) @ $150.00	900	
Randomatic Fiche Sorter[1]	2,000	
Equipment Total	4,925	550/month
Labor (4 people/6 months)	10,000	
Total	14,925	550/month

[1]Same equipment for both methods (Recommendations 2 and 3). Duplicate purchases are not needed to implement the unitized microfiche method.

3. Implement the unitized method for producing microfiche with a target completion date 6 months from go-ahead. The major items of equipment, such as the step-and-repeat camera, should be leased on a monthly basis and should be covered by contracted maintenance service. Estimated total costs are as follows:

Equipment	Purchase (dollars)	Lease (dollars)
Microcard Step-and-Repeat Camera[1]		750/month (40 fiche up to 1,250; 0.25 per fiche after that)
Photo Devices Step-and-Repeat Camera[1] (Selling price: $34,000)		1,200/month
Developer (Selling price: $2,500)		85/month
Automatic Cutter (Selling price: $2,950)		95/month
Colite Fiche Duplicator[2]	745	
Kalvar Developer[2]	285	
Xerox 1824 Printer[2]		205/month
Documat Reader-Printer[2]	995	
Microcard FR-5 Reader[2] (6) @ $150.00	900	
Randomatic Fiche Sorter 1500[2]	2,000	
Equipment Total[2]		1,585/month
Labor (2.1 people/year)	14,000	
Total	14,000/year	1,585/month

[1]The leased cost total of $1,585 includes the cost of just one camera at $1,200/month.

[2]Same equipment for both methods (Recommendations 2 and 3). Duplicate purchases are not needed to implement the unitized microfiche method.

4. Establish a mechanized retrieval microfiche file on all Engineering data files, such as PIR's, specifications, design specifications, MIL Standards, and so on, for the immediate use of Engineering and other personnel.

Cost Summary

The total cost investment in purchased equipment, based upon Recommendations 2 and 3, is $4,925.

The total estimated cost for leased equipment per year amounts to

First Year

(Recommendation 2), $550 x 6	$ 3,300
(Recommendation 3), $1,585 x 6	9,510
Total	$12,810

Second Year

(Recommendation 3), $1,585 x 12	$19,020

Since the second-year leasing cost exceeds 50 percent of the purchase price of the step-and-repeat camera listed in Recommendation 3, it is further recommended that the balance of equipment leased be considered for purchase.

D. Microcard System

1. General Description

Microcards are positive opaque photographic prints, 3 by 5 inches.[1] They are used to reproduce and distribute handwritten, typewritten, and printed materials, as well as photographs, charts, drawings, and symbols. Normally, 40 letter-size pages (approximately 8-1/2 by 11 inches) or 80 book-size pages (approximately 5-1/2 by 8 inches) can be photographically printed on each side of the card from specially prepared microfilm strips. Descriptive information that can be read with the naked eye is multilith-printed along the top of each card, or can be printed on the reverse side if only one side of the Microcard is photoprinted.

The negative filming of the original records is done in Los Angeles by the Recordak Corporation. The original records are sequentially arranged, indexed, photographed, and returned to the customer. The negatives are photographically printed on sensitized photographic paper by the Microcard Corporation at one central location. The required number of contact copies are made, and the finished Microcards are delivered to the customer. Only a Microcard reader and printer are needed to complete the system. (See Exhibits 17 and 18.) Although the master negatives are the property of the customer, they may be stored without charge in the controlled-atmosphere vault of the Recordak Corporation.

Exhibit 16 presents general characteristics, cost, and weight of Microcards. Cost factors are based on data received from the Microcard Corporation. Exhibit 17 lists the associated equipment that must be purchased to complete the Microcard system. Microcards are primarily used by customer service and maintenance engineers. Condensation of maintenance manuals, service manuals, and parts catalogs to Microcard size provides "mobility" for a large volume of printed information. For this type of application, portable Microcard readers complete the system

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[1] Microcard is a registered trade name of the Microcard Corporation. Other micro-opaque cards are available under their trade names. For convenience, this discussion is limited to Microcards.

EXHIBIT 16 - MICROCARD CHARACTERISTICS

Specifications

1. Card size: 3 x 5 inches
2. Page reduction ratio: 1:18
3. Pages per card: Approximately 80 (letter size)
4. Filing: 65 cards per inch
5. Weight: 1/7 oz.
6. Printing cost: 1/5 to 1/2 cents per reproduced page
7. Economical run: 10 to 20,000 copies
8. Life: Permanent

Cost Comparison

300 copies of an 80-page manual cost about $50 to print on microcards, or less that 17 cents per copy. The equivalent full-size photo offset printing costs about $600 or $2 per printed copy.

Weight

1.	5,000 pages on microcards	8 oz.	1. 5,000 pages full-size photo offset	30 lbs.
2.	Pocket carrier for microcards	4 oz.	2. Binders	5 lbs.
3.	Microcard hand reader	6 oz.	3. Carrying case	5 lbs.
	Total	18 oz.	Total	40 lbs.

Distribution Cost

63 microcards (5,000 pages) airmailed anywhere in the United States	$0.64
5,000 pages full size, fourth class mail	$5.94

Space

63 microcards (5,000 pages) make a deck 1 inch thick; a hand reader adds another inch. Total size of microcards and reader is about that of a 35 mm camera.

5,000 letter-size pages occupy 15 inches of shelf space; the same space can store over 500,000 pages on microcards.

EXHIBIT 17 - MICROCARD EQUIPMENT

Type	Specifications	Use	Remarks	Price
Hand Reader (with or without built-in light source)	1. Slightly larger than a package of king-size cigarettes 2. Wide-field 12X lens 3. Adjustable focus for individual eyesight 4. Weight: 6 oz	1. Suitable for maintenance tool kits where quick reference is required 2. Designed to be carried in the pocket	1. Must be used for spot-reference purposes only 2. Undue eyestrain may result from prolonged use	$ 14.95
Micro III Reader (portable)	1. Portable size: opened, 9 x 13 x 12 inches; closed, 9 x 13 x 3 inches 2. Viewing screen: 8 x 10 inches 3. Magnification: 19X 4. Electrical requirements: 110-volt AC (also available for 220-volt AC and for low DC voltage) 5. Weight: 6 lbs	1. Used for field or stationary applications 2. Designed to produce a sharp image under ordinary room light 3. Can also be used with microfiche	A portable 90,000-page information library on microcards weights 15 lbs., including the Micro III reader	$129.95
Mark VII Reader (desk-top reader)	1. Table model size: 10-1/4 x 15 x 17-1/2 inches 2. Viewing screen: 9-3/4 x 10-1/2 inches 3. Magnification: 23X 4. 300-watt illumination system	1. Used for desk-top applications 2. Designed to produce a sharp image under ordinary room light	Viewing screen can be tilted for reading comfort	$450.00

EXHIBIT 17 (Continued)

Type	Specifications	Use	Remarks	Price
Mark VII Reader (desk-top reader) (continued)	5. Electrical requirements: 110-volt AC (also available for 220-volt AC) 6. Weight: 24 lbs			
Model I Copier	1. Size: 13-1/2 x 17 x 29 inches 2. Weight: 71 lbs 3. Printing process: diffusion/transfer/reversal 4. Size of print: 8-1/2 x 13 inches 5. Size of image on print: 8-1/4 x 10 inches 6. Cost of negative and positive roll, 8-1/2 x 98 inches: $10.76 7. Cost per print: $0.12 8. Cost of chemical per quart: $1.15 9. Approximate cost of chemical per print: 2/3 cent	Used to automatically produce an enlarged positive copy of a page of text from a microcard. Print is produced in 30 seconds.	This machine is not a true reader-printer since it does not have a screen for reading an enlarged view of a microcard image being projected. It has, instead, an eyepiece for viewing the microcard to locate and position the desired page for printing.	$950.00

EXHIBIT 17 (Continued)

Type	Specifications	Use	Remarks	Price
Model I Copier (continued)	10. Number of prints per roll: 90			
	11. Electronic exposure timer			
	12. Electrical requirements: 120-volt AC			

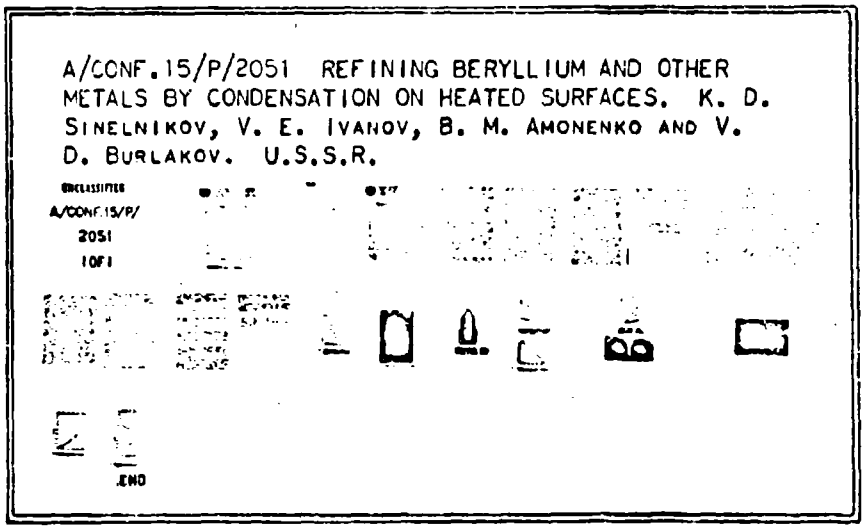

EXHIBIT 18 - MICROCARD

2. System Capabilities and Limitations

The Microcard system is favored for a service function where (1) the users can be selected or are limited and the material requires frequent revisions (i.e., catelog price list changes or part number changes), and (2) the content is fixed data to which frequent reference is made. This type of fixed-data material (e.g., mathematical tables, notations, and equations, color correction charts for film processing labs, or instruction steps for complicated machine operations) can be carried conveniently by the user for rapid referral.

No capital outlay for microfilm and production equipment is necessary with Microcards; all microfilming and printing is done by the Microcard Corporation. However, prior to microfilming, the original documents must be suitably indexed, fairly standard in size and shape, and sequentailly arranged in proper filming order. After an initial negative charge of $2.00, Microcards cost only a few cents to reproduce (see Exhibit 16).

Microcards can be indexed, stored, and retrieved manually by using visible descriptive information along the top of each card. This information can contain the classification or titles of the original records, a code number, an accession number, or any other type of identification.

A notation that a card is one of a series on a given subject may also appear. Such notations facilitate search and file because they are visible without enlargement. When searching or filing a Microcard, extra handling precautions typical of other microfilm systems need not be exercised because Microcards are durable and the microimages appear under the surface of the card. Microcards withstand handling abuse better than reels of film or aperture cards, and the microimages cannot be harmed by water, grease, or abrasions.

Duplicate decentralized files can be easily created and located at a remote site at a very low cost. Because Microcards are of standard library card size, they are convenient for handling, mailing, and filing. They can be stored in standard 3-by-5-inch card files.

To revise a Microcard, a new original is made, revised, and sent in for processing. The revised page is microfilmed, and the negative is

substituted onto the master negative card. The entire card is then photoprinted and reissued.

The Microcard system has some major problems. For example, processing time is approximately 10 days for either original or revised copy. Also, according to recent tests, hard copies made with the Model 1 Microcard Copier have three major faults: (1) unevenness of the field of illumination; (2) excessive contract exhibited by the diffusion-transfer-reversal paper employed; and (3) variations in the clarity and quality of the Microcard images. These faults result in waste through trial-and-error efforts to produce a clear copy from finely detailed originals.

The excessive delay encountered in the processing of Microcards seriously hampers an operation that is based on a rigid revision schedule, where writing, reviewing, and production of current materials must be periodically cycled in the minimum amount of time. Also, the quality of the Microcard equipment (see Exhibit 17) still needs improvement.

The ideal microfilming system must be able to produce enlarged copies of microdocuments in quantity for quick-reference purposes. Essentially, such an apparatus would be a high-rate printer--the type currently employed in other microfilming systems (e.g., the aperture card system). The Microcard system has only one printer, and it is incapable of producing more than one copy in 30 seconds.

3. Personnel and Training Requirements

No special training is required to operate any Microcard equipment. The Model I Microcard Copier is fully automatic and operated by pushing a button. Gaining familiarity with the Microcard readers is the only training required.

V. CONCLUSIONS AND RECOMMENDATIONS

This section presents a summary of the uses, advantages, and disadvantages of the microfilm systems discussed earlier and a quantitative comparative evaluation of the different approaches. Conclusions are made, based on the evaluation.

A. Summary of Microfilm Systems

1. 16mm Roll Film

Documents are usually microphotographed on 100-foot roll film.

a. Primary Uses

Primarily used to record documents of 8-1/2 x 11 inches or less in width. (Records for letters, books, bank checks, personnel records, medical records, technical reports, etc.)

b. Advantages

(1) May save up to 75 to 95 percent of storage space required for hard copies.
(2) Very economical format for sequence recording.
(3) Very economical for long-term record storage.
(4) Easy to file.
(5) Easy to use for reference purposes.
(6) Easy to duplicate.
(7) Wide selection of related equipment available for purchase or rental.
(8) Service companies located in all large cities.

c. Disadvantages

(1) Difficult to make revisions or additions to the microfilmed sequence.
(2) Difficult to index all images.
(3) Slow in finding a specific image on request.

(4) Not currently used in or compatible with other microforms, since other forms are usually on 35mm film.

2. 35mm Roll Film

Documents are usually microphotographed on 100-foot roll film.

a. Primary Uses

Primarily used to record documents from 16 to 35 inches in width. (Records for engineering drawings, maps, newspapers, charts, etc.) Also used for document dissemination in some military applications.

b. Advantages

(1) Best for storage of large documents.
(2) Easy to use for reference purposes.
(3) Easy to file.
(4) Wide selection of related equipment available for purchase or rental.
(5) Easy to duplicate.
(6) Image (single or multiple) can be cut from the roll and easily mounted on standard aperture card, or used for film strips, microfiche, etc.
(7) Service companies located in all large cities.

c. Disadvantages

(1) Difficult to make revisions or additions to the microfilmed sequence.
(2) Difficult to index all images.
(3) Slow in finding a specific image on request.
(4) Cost of film increases sharply over 16mm film.

3. Microfilm Jacket

One or more frames of 16mm and/or 35mm microfilm strips are mounted on a card and placed in a protective acetate or paper jacket.

a. Primary Uses

Used to group multiple frames of microfilm on one subject, regardless of differences in the size of the microfilm.

b. Advantages

(1) Full freedom to make additions or revisions to jacket file.

(2) Easy to group subject matter by using one or more sequenced jackets.

(3) Reduces random search time of a specific subject.

(4) Easy to index and file.

c. Disadvantages

(1) Difficult to set up duplicate decentralized files.

(2) Difficult to make film copies of a jacket file for fast distribution.

(3) Difficult to locate one item of the multiple items stored within the jacket.

(4) Difficult to account for contents of file.

4. Aperture Card

Microfilm, usually 35mm, is mounted in standard data processing card.

a. Primary Uses

(1) Used to record engineering drawings from 8-1/2 x 11 inches to 36 x 48 inches in size.

(2) Also used to record technical reports, parts lists, maps, charts, tables, drawings, etc.

b. Advantages

(1) May save up to 96 percent of storage space required by conventional sizes.

(2) Aperture card size is standardized and meets Government regulations.

(3) Easy to maintain duplicate decentralized files.

(4) Easily integrated into automatic data processing systems.

(5) Easy to file, retrieve, reproduce, and distribute information.

(6) Easily packaged and mailed.

(7) Easy to make additions or revisions since one card usually represents only one to four pages of the original text or drawing.

(8) Wide selection of related equipment available for purchase or rental.

(9) Service companies located in all large cities.

c. Disadvantages

(1) Limitations in page length or add-ons.

(2) Page sequence difficult to keep track of, once a card is misplaced in a manually kept file.

(3) Marked increase in overall cost for equipment and supplies.

(4) Normally, only one or two pages of text carried on a single card; thus many cards must be used to microrecord large files.

(5) Spoilage costs of card stock are high.

5. Microcard

A microcard is a positive photographic print 3 x 5 inches in size.

a. Primary Uses

(1) Used to record 36 to 40 pages of text on one side of a card. Both sides of the card may be photoprinted.

(2) Often used for reference to catalogued parts, provisioning orders, sales, prices, technical data, etc., where the application requires the ability of the card to stand frequent use and abuse.

b. Advantages

(1) May save up to 92 to 96 percent of storage space required for hard copies.

(2) Very convenient for handling, mailing, and filing because the dimensions are of standard library card size.

(3) Withstands handling abuse better than reels of film or aperture cards.

(4) Easily carried in the shirt pocket for fast reference.

(5) More durable and less expensive than microfilm.

(6) No binding necessary.

(7) Small portable readers available at low cost.

c. Disadvantages

(1) Loss of one microcard equivalent to losing from 36 to 80 pages of text.

(2) Magnified image quality not as good as microfilm.

(3) Cannot revise a single image without affecting 36 to 80 pages of microtext at the same time.

(4) Photographic and processing plants are not nationwide.

(5) Enlarged prints (original size) from microcard reader-printer not perfected.

(6) Long waiting time between microfilming of original text and receiving microcards.

6. Microfiche

Sheet film, now at a standardized size of 4 by 6 inches, is used. Alternative sizes may be used.

a. Primary Uses

(1) Used to record 60 (or up to 160) pages of text at a reduction ratio from 10 x to 28 x.

(2) Used to record books, periodicals, scientific journals, and related library-type documents.

(3) Applications of microfiche to many commercial purposes are growing very rapidly (i.e., medical records, business records, land titles, and municipal legal records, etc.).

b. Advantages

(1) May save up to 92 to 96 percent of storage space used for conventional documents.

(2) Storage is more convenient and economical than roll film.

(3) Filing and retriving is more convenient than roll film, since microfiche contains author, title, page numbers, and other full-size information at the top of each sheet.

(4) With the step-and-repeat microfiche camera, the negative can be developed quickly and economically. (If necessary, the negative can be developed in 3 minutes using the crudest equipment and a closet for a darkroom).

(5) A full-size print of each page can be economically produced by standard photographic enlarging methods.

(6) Readers for transparent materials are more common and less complicated than for opaque materials.

(7) Microfiche is required by NASA and some DOD agencies.

c. Disadvantages

(1) Reduction ratio not sufficiently standardized; therefore, it is difficult to accommodate all the various image sizes with a single reader.

(2) Loss of 1 sheet equivalent to losing from 60 to 160 pages of text.

(4) Special equipment or modifications required to use microfiche and roll film or aperture card.

(5) Positioning for viewing or printing is critical.

(6, High-speed electrostatic-printing-type equipment has not yet been adapted to microfiche, and thus other methods of volume reproduction must be used.

(7) Indexing and retrieval of individual items is difficult.

B. Comparative Evaluation and Conclusions

1. Comparative Evaluation

Exhibit 19 is a quantitative comparison of the five microfilm document storage and retrieval systems that have been discussed. Microfiche is subdivided into the unitized and microfolio methods, thus making six techniques to compare in all.

Along the left side of the exhibit are 20 factors, subdivided into (1) capabilities, (2) limitations, and (3) cost. The values in the table were determined by judging each of the six methods in terms of a 7-point scale, and assigning a score ranging from 0 to 6. The scoring was arranged so that the high value always represents the best relative performance, whatever the factor happens to be.

In terms of the cost of the microcard system, the score represents the fact that microcards are only produced by what is essentially a service-bureau operation.

One thing should be noted about this method of evaluation. All the factors are treated as though they were of equal value to a potential buyer of a system. In practice, this is almost certain not to be true. For some users, cost will be of much higher value than, say, high storage density. For others, the speed of information retrieval may outweigh any consideration of price, within the range of costs at stake here.

In order to apply such weighting factors and further refine this evaluation, the reader must consider each of the 20 factors in relation to his own requirements, and assign a numerical value to them. This can be done as follows: Begin by assuming each factor has a value of 1. Then consider the relative importance of each factor in turn. If "rapid input preparation" is twice as important as "easy-to-generate repro master" then the first factor must have a numerical value double that of the second factor. In order to carry this out for all factors, a cross-tabulation should be made to assure that all possible comparisons are made. In practice, however, it usually turns out that a relatively small number of factors are of critical concern in any given application. In this case, only those need be weighted.

EXHIBIT 19 - COMPARATIVE EVALUATIONS

Characteristic	Unitized Micro-fiche	Folio Micro-fiche	Jacketed Film Strips	Micro-cards	Aper-ture Cards	Roll Film
Capabilities						
o Rapid Input Preparation	5	4	4	1	4	5
o High-Speed Film Processing	6	6	6	3	6	6
o High Storage Density	6	6	4	5	3	6
o Easy To Update	3	4	3	0	3	1
o Rapid Information Retrieval	6	6	4	4	5	4
o Easy To Duplicate Microform	6	6	2	0	5	6
o Easy To Generate Facsimile	6	6	4	5	5	5
o Easy To Generate Repro Master	4	4	3	3	5	5
o Minimal Storage Space	6	6	5	5	4	3
o Easy To Use Microform as Reference	6	6	5	5	6	3
o Withstands Abuse	4	4	5	6	4	4
o High Image Quality	6	6	6	4	6	6
o Potential for Future Development	6	4	1	2	4	3
Limitations						
o Not Suitable for Duplication	6	6	0	0	5	6
o Hard To Make Single-Frame Film Copy	6	6	3	5	5	3
o Cannot Purchase Complete System	5	5	3	0	6	6
Cost						
o Purchase of System	4	5	5	0	5	6
o Ownership of System	5	4	3	0	5	5
o Per-Document Cost (high work volume)	4	3	2	3	3	6
o Per-Document Cost (low work volume)	3	4	4	2	3	4
Total Unweighted Evaluation Score	103	101	72	53	92	93

When the appropriate weights are assigned, the numbers in the corresponding rows of the table are multiplied by the new value. The rows are then retotaled to give weighted evaluation scores.

The detailed results of the evaluation are self-evident in the exhibit. The rankings of the systems are as follows:

1. Unitized microfiche
2. Microfolio microfiche
3. Roll film
4. Aperture cards
5. Jacketed film strips
6. Microcards

A minor reweighting of some of the factors could easily cause the two microfiche methods to reverse their relative positions; the same could occur for roll film and aperture cards. A relatively major reweighting would have to occur, however, in order to place any other method over microfiche.

2. Conclusions

It is the conclusion of this report that the 4-by-6-inch microfiche format, containing 60 document-page images per record, is the best of today's approaches for technical document storage and retrieval in the Federal Government. It is considered to be an adequate concept for most of the applications that can be foreseen for at least the next 10 years. In this connection, this report concurs with conclusions reached earlier by DDC, AEC, NASA, and the Federal Council for Science and Technology. Perhaps 90 percent of most technical reports, documents, dossiers, case histories, and similar items in which the consecutive pages are subject related are less than 300 pages in length, and can be stored on 1 to 5 microfiches. Over one-half of all such items are estimated to be less that 60 pages in length and can be stored on a single microfiche. The 60-page format is a good compromise between the conflicting requirements of (1) unifying subject-related pages; (2) keeping unrelated items separated, and therefore easily retrieved for other users or removed for obsoletion; and (3) having a minimum number of only partially filled microfiches in the working files.

Made of film stock 50 percent heavier than conventional microfilm, long-life microfiche cards stand up under extensive field use. The life expectancy is as great as a good grade of bond paper: about 100 years.

Because of Government requirements for microfiche, hardware manufacturers are continuing research and development activities on equipment. Further, intensive standardization activities are taking place with leading manufacturers and users of microfiche participating.

Microfilm service organizations usually provide the same services for microfiche as for other microforms. Outside service costs for microfiche compare favorably with those for aperture cards on a per-page basis. An aperture card costs 10 cents for up to 4 images, and a 5-by-8-inch microfiche costs 30 cents for up to 84 images.

Microfiche equipment has largely been adapted from roll film or aperture card equipment rather than specifically designed for microfiche. Less sophisticated equipment is more easily modified for microfiche; therefore, microfiche equipment has tended to be somewhat less sophisticated than roll film or aperture card equipment.

With the standardization of microfiche at 4 by 6 inches, equipment manufacturers can be expected to improve their equipment much more rapidly than was the case previously. Standardization has not yet been effected in the size and location of the image relative to the edges of the film, in the number of images to the sheet, and in the reduction ratio to be used. However, NASA and others are using a 5-row, 12-image arrangement. NASA and AEC are both using an 18:1 reduction ratio, and a center-to-center image frame distance of 16-1/2 by 23-1/2mm.

The continued standardization should lead rapidly to the development of automatic, precise positioning capability for high-volume reproduction equipment, such as the Copytron and Copyflo machines. For the present, however, volume reproduction can be accomplished by the preparation of offset masters or vellum masters from the microfiche.

In summary, it is believed that the microfiche system offers both the best of today's state of the art in microfilming and the most potential for still further flexibility due to future development.

APPENDIX I

MICROFILM, MICROFICHE READER, AND PRINTER COMPARISON CHART

Manufacturer	Model	Cost	Processing Method	Magnification Ratio (to nearest whole number)	Microfilm Format Roll, Aperture Card, Microfiche	Screen Size (inches)	Maximum Print Size (inches)	Repro Master	Seconds Per Print
Atlantic Microfilm Corporation 300 South Main Street Spring Valley, New York 10977	576-75 Reader	$250		24 variable	Aperture card, microfiche	11 x 14			
	MJR-85A Reader	$198		7, 11, 16, 22 fixed	Roll, aperture card, microfiche	10 x 10			
	F-66 Reader	$99		19, 24 fixed	Roll, aperture card, microfiche	8-1/2 x 11			
Bell & Howell 6800 McCormick Road Chicago, Illinois 60645	Headliner Reader			24 fixed	Microfiche	14 x 14			
	Autoload II Reader, Enlarger			20 to 40 variable	Roll	14 x 14			
	Autoload II Reader-Printer, Enlarger		Stabilization	20 to 40 variable	Roll	14 x 14	8-1/2 x 11	Sensitized paper	10
	530D Reader-Printer, Enlarger		Stabilization	11, 13, 20, 28, 34, 37 variable	Roll, aperture card, microfiche	11 x 11	8-1/2 x 11	Sensitized paper	10
	530U Reader, Enlarger			11, 13, 20, 28, 34, 37 variable	Roll, aperture card, microfiche	11 x 11			
Bruning, Inc. 1800 West Central Road Mt. Prospect, Illinois 60056	1100 Printer, Enlarger	$6,975	Electrostatic	14 to 16 variable	Roll, aperture card	7 x 5	18 x 24	Offset; translucent	
Caps Equipment, Ltd. London, England	M1 through M9 Caps-Jeffree Modular	$6,505 to $18,520	Diazo, silver-halide, lithographic, ultraviolet	6 to 26 variable	Roll, aperture card, microfiche	20 x 30 (M1), 24 x 36 (M2), 30 x 40 (M3)	30 x 40	Any photo-sensitive material	

MICROFILM, MICROFICHE READER, AND PRINTER COMPARISON CHART (Continued)

Manufacturer	Model	Cost	Processing Method	Magnification Ratio (to nearest whole number)	Microfilm Format Roll, Aperture Card, Microfiche	Screen Size (inches)	Maximum Print Size (inches)	Repro Master	Seconds Per Print
Caps Equipment, Ltd. (Continued)	Microfilm Equipment Reader-Printer, Enlarger								
Data Reproduction Systems 300 East Beach Avenue Inglewood, California 90302	Model II DRS Micro-Reader	$149.50		11, 12, 16, 18, 24 fixed	Roll, aperture card, microfiche	11-1/4 x 11-3/8			
Documat, Inc. 84 Fourth Avenue Waltham, Massachusetts 02154	300A Reader-Printer	$1,495	Stabilization	11, 13, 20, 28, 34 variable	Roll, aperture card, microfiche	11 x 11	7 x 9-1/4	Sensitised paper	30
	200A Reader, Enlarger	$895		15, 25, 35	Roll, aperture card, microfiche	11 x 11			
	Mark 1 Reader	$425	Stabilization	15, 25, 35	Roll, aperture card	11 x 11	7 x 9-1/4	Sensitised paper	30
	Mark 2 Reader-Printer	$920	Stabilization	11, 13, 20, 28, 34 variable	Roll, aperture card	11 x 11	7 x 9-1/4	Sensitised paper	30
	Mark 2 "Half Size" Reader-Printer	$995	Stabilization	11, 13, 20, 28, 34, variable	Roll, aperture card	11 x 11	4-1/2 x 7	Sensitised paper	30
	Mark 18 Reader-Printer	$2,695	Stabilization	12, 14, 16 interchangeable	Roll, aperture card, microfiche	18 x 24	17 x 23	Sensitized paper; trans-lucent available	30
Documentation, Inc. 4833 Rugby Avenue Bethesda, Maryland 20014	1010 Reader	$199.50		18, 24 fixed	Roll, aperture card, microfiche	10 x 10			
	Mark V Reader-Printer	$695		18	Aperture card, microfiche	8 x 10	8 x 10	Sensitized paper	

MICROFILM, MICROFICHE READER, AND PRINTER COMPARISON CHART (Continued)

Manufacturer	Model	Cost	Processing Method	Magnification Ratio (to nearest whole number)	Microfilm Format Roll, Aperture Card, Microfiche	Screen Size (inches)	Maximum Print Size (inches)	Repro Master	Seconds Per Print
Documentation, Inc. (Continued)	Alpha 1010 Micro-densitom-eter Reader	$795		18	Aperture card, microfiche	10 x 10			
	Micro-system Page Printer, Reader	$6,950		16, 23, 45	Aperture card, microfiche	8-1/2 x 11	8-1/2 x 11	Sensitized paper and translucent	
	Card to Roll Processor and Duplicator	$27,500	Diazo					Diazo rolls	
DuKane Corp. 103 N. 11th Street St. Charles, Illinois 60174	576-75 Reader	$250		21 fixed	Microfiche	11 x 14			
	576-80 Reader	$209.50		15 fixed	Roll, aperture card	10-1/2 x 12			
	576-90 Reader	$189.50		15 fixed	Aperture card	10-1/2 x 12			
	576-95 Reader	$198.50		15 fixed	Aperture card, microfiche	10-1/2 x 12			
	27A5 Reader	$125 (micro-fiche) $155 (roll film)		20 fixed	Roll, aperture card, microfiche	10 x 13			
Durst (USA), Inc. - (sub-sidiary of Ehrenreich Photo-Optical Industries, Inc.) 623 Stewart Ave. Garden City, New York 11533	M-35 Reader Enlarger	$425 and $460	Photo	16	Roll		16 x 20	Sensitized paper	

MICROFILM, MICROFICHE READER, AND PRINTER COMPARISON CHART (Continued)

Manufacturer	Model	Cost	Processing Method	Magnification Ratio (to nearest whole number)	Microfilm Format Roll, Aperture Card, Microfiche	Screen Size (inches)	Maximum Print Size (inches)	Repro Master	Seconds Per Print
Eastman Kodak Co. Business Systems Markets Division 343 State Street Rochester, New York 14650	20/20 Portable Film Reader Model P-20	$475		20 fixed	Roll	9 x 12			
	Precision Reader-Printer Model PR-1824	$2,995	Silver/ stabilization	15 fixed	Roll, aperture card, microfiche	17-7/8 x 24	17-7/8 x 24	Diazo, offset (translucent, recordak verilith plate, type N)	30
	Lodestar Model PES Reader-Printer	$2,650	Silver/ monobath	21, 23 fixed	Roll	13 x 13	8-1/2 x 11-1/4	Sensitized paper	28
	Magnaprint Model PE-1A Reader-Printer	$1,250	Silver/ monobath	12 to 38 variable	Roll, aperture card, microfiche	11 x 11	8-1/2 x 11-1/4	Sensitized paper	26
	Miracode Reader-Printer Model PEK	$14,945	Silver/ monobath	21, 23 fixed	Roll	11-1/2 x 13	8-1/2 x 11		28 (1st 14 thereafter)
	Filmcard Reader Model PFC-46-1	$209.50		20, 23, 27 fixed	Aperture card, microfiche	10-1/2 x 13-1/4			
	Filmcard Reader PFC-58	$209.50	18, 23 fixed	Microfiche	10-1/2 x 13-1/4				
	310 Film Reader Models PV and PVA	$395 (model PV) $435 (model PVA)	20, 24, 32, 40 fixed	Roll	9 x 12				

MICROFILM, MICROFICHE READER, AND PRINTER COMPARISON CHART (Continued)

Manufacturer	Model	Cost	Processing Method	Magnification Ratio (to nearest whole number)	Microfilm Format Roll, Aperture Card, Microfiche	Screen Size (inches)	Maximum Print Size (inches)	Repro Master	Seconds Per Print
Federal Division The Victoreen Instrument Co. 1055 Stewart Avenue, Garden City, New York 11533	MM24 Reader-Printer, Enlarger	$495	Stabilization	17 fixed	Roll, aperture card	18 x 24	18 x 24	Diazo, offset	20
	473 Reader-Printer	$395	Stabilization or diffusion transfer	19 fixed	Roll, aperture card, microfiche	8 x 9-1/2	7-1/2 x 9-3/4 (stabilization) 8 x 9-1/2 (diffusion)	Translucent	9
General Aniline and Film Corp. 140 W. 51st Street New York, New York 10020	Microline 1824 Reader-Printer, Enlarger	$2,845	Stabilization	15 fixed	Roll, aperture card	18 x 24	18 x 24	Diazo	30
	5685 Portable Reader	$198		7, 11, 17, 22 variable	Roll, aperture card, microfiche	10 x 10			
Gordon Enterprises 5362 N. Cahuenga Boulevard North Hollywood, California 91601	EN44A Reader-Printer	$8,950		To 14 variable	Roll, aperture card	17 x 22	17 x 22		57
Griscombe Products (Division of Eugene Dietzgen Co.) P.O. Box 1793 North Brunswick, New Jersey 08902	PA Series Reader	$220	Optical	17, 23, 30, 43 fixed	Roll	14 x 14			
	KE Series Reader	$275	Optical	17, 24, 30, 43	Aperture card, microfiche	12 x 12			
	KJ Reader	$189	Optical	15, 20 fixed	Aperture card	10-1/2 x 12			
	KGA Reader	$850	Optical	15 fixed	Roll, aperture card, microfiche	10 x 24			
	RB Reader	$515	Optical	17, 24, 30, 43	Roll	12 x 12			
	4305 Reader	$189		15, 20 fixed	Aperture card	10-1/2 x 12			

MICROFILM, MICROFICHE READER, AND PRINTER COMPARISON CHART (Continued)

Manufacturer	Model	Cost	Processing Method	Magnification Ratio (to nearest whole number)	Microfilm Format Roll, Aperture Card, Microfiche	Screen Size (inches)	Maximum Print Size (inches)	Repro Master	Seconds Per Print
Hudson Photographic industries, Inc. S. Buckhout St. and Station Road Irvington-On-Hudson, New York 10533	372 Reader	$99.50	Optical	7 fixed	Aperture card	10 x 10			
International Business Machines Corp. Information Records Division P.O. Box 10 Princeton, New Jersey 08540	IBM 9949 Micro-Viewer Reader	$210 (aperture card) $234 (roll)		7, 15 variable	Roll, aperture card	8 x 10			
	IBM 9952 Micro-Viewer/ Printer Standard RF (Reader)	$2,845 to $2,995	Stabilization	15 fixed	Roll, aperture card	18 x 24	18 x 24	Sensitized paper	30
	IBM 9921 Document Viewer Model I (Reader)	$300		24, 30 variable	Aperture card, microfiche	14 x 15			
	IBM 9922 Document Viewer Model II (Reader)	$400		24, 30 variable	Aperture card, microfiche	14 x 22			
	Micro-Viewer I (Reader)	$210 (aperture card) $234 (roll)		7, 15 variable	Roll, aperture card	8 x 10			
	Micro-Viewer Printer Standard and RF	$2,845 to $2,995	Stabilization	15 fixed	Roll, aperture card, microfiche	18 x 24	18 x 24	Diazo, offset, translucent	30

MICROFILM, MICROFICHE READER, AND PRINTER COMPARISON CHART (Continued)

Manufacturer	Model	Cost	Processing Method	Magnification Ratio (to nearest whole number)	Microfilm Format Roll, Aperture Card, Microfiche	Screen Size (inches)	Maximum Print Size (inches)	Repro Master	Seconds Per Print
Industrial Design and Service Co. 685 Route 17 Paramus, New Jersey 07652	40 Universal Reader	$129		15, 20 fixed	Roll, aperture card, microfiche	10-1/2 x 12			
Itek Business Products 1001 Jefferson Road Rochester, New York 14603	18.24 Reader-Printer	$2,845 to $3,395	Stabilization	15 fixed (others optional)	Roll, aperture card, microfiche	18 x 24	18 x 24	Diazo, offset	30
Kalvar Corp. 819 Monen Road Burlingame, California 94010	K-10 Printer	$895	Heat developable		Aperture card, microfiche	8 x 10		Sensitized paper	
	MMR-400 Printer	$4,950	Heat		Roll				
	High-Speed Conversion Unit for Instant 80 Kalkards Printer	$3,975			Aperture card				
	Kalkard Exposer 200 and Kalkard Activator 240 Printer	$1,145 per set	Light		Aperture card				
Keuffel and Esser Co. 300 Adams Street Hoboken, New Jersey 07030	52 2004 Reader	$99.50		3 fixed	Roll	4-1/4 x 7			
	52 2033 Reader-Printer	$545		15 fixed	Roll, aperture card	18 x 24	16 x 24	Sensitized paper; translucent; opaque	5
	52 2035 Reader	$550		4 fixed	Aperture card	15 x 23			
	52 3021 Reader-Printer	$545	Stabilization	4 fixed	Aperture card	18 x 24	[illegible]	[illegible] paper; translucent; opaque	[illegible]

MICROFILM, MICROFICHE READER, AND PRINTER COMPARISON CHART (Continued)

Manufacturer	Model	Cost	Processing Method	Magnification Ratio (to nearest whole number)	Microfilm Format Roll, Aperture Card, Microfiche	Screen Size (inches)	Maximum Print Size (inches)	Repro Master	Seconds Per Print
Keuffel and Esser Co. (Continued)	52 2038 Reader-Printer	$4,200	Stabilization	4 fixed	Roll	18 x 24	18 x 24	Sensitized paper; translucent; opaque	30
Microcard Corp. 365 E. Oak Street W. Salem, Wisconsin 54669	EL-4 Printer, Enlarger		Dry silver	18 fixed	Microfiche		8-1/2 x 11	Sensitized paper; dry silver paper	5
	ER-5 Reader	$125		17, 22 variable	Aperture card, microfiche	7-5/8 x 9-1/8			
	Mark IV Reader	$350		18 fixed	Aperture card, microfiche	9-1/2 x 11			
	Mark VII Reader	$450		23 fixed	Aperture card	9-7/8 x 10-1/8			
	Micro III Reader	$200		19 fixed	Aperture card, microfiche	8 x 9-1/2			
Microdealers, Inc. 1560 Trapelo Road Waltham, Massachusetts 02154	708B Reader	$89.50		10 fixed	Roll	10 x 13			
	708C Reader	$199		12 fixed	Roll, aperture card	18 x 12			
	708D Reader	$449 (includes 26" stand)		15 fixed	Roll, aperture card, microfiche	18 x 24			
Microreader Mfg. and Sales Corp. 2217 N. Summit Avenue Milwaukee, Wisoncsin 53202	Micro-reader RTU Reader-Printer Enlarger	$350	Dry	10, 15, 18, 27, 37 variable	Roll, aperture card, microfiche	7 x 9	7 x 9	Diaso	10
	Micro-skaner Reader	$15		20	Roll, aperture card, microfiche	20x			
	Micro-reader 2016 Reader	$95		13, 20	Roll, aperture card, microfiche	20x			

MICROFILM, MICROFICHE READER, AND PRINTER COMPARISON CHART (Continued)

Manufacturer	Model	Cost	Processing Method	Magnification Ratio (to nearest whole number)	Microfilm Format Roll, Aperture Card, Microfiche	Screen Size (inches)	Maximum Print Size (inches)	Repro Master	Seconds Per Print
Microreader Mfg. and Sales Corp. (Continued)	Micro-reader 1316 Reader	$95		13, 20	Roll, aperture card, microfiche	13x			
Microseal Corp. 6302 N. Cicero Avenue Chicago, Illinois 60646	V-2 Viewer Reader	$550		15 fixed	Roll, aperture card	18 x 24			
	1601 Viewer-Film Mounter Reader	$800		15 or 32 fixed	Roll, aperture card, microfiche	10-1/2 x 12			
Mosler Safe Co. Grand Boulevard Hamilton, Ohio 45012	Rotriever Reader-Printer		Electrolytic	15	Aperture card	18 x 24			30
3M Co. 2501 Hudson Road St. Paul, Minnesota 55119	3M-200 Reader-Printer, Enlarger	$1,495	Electrochemical	15	Aperture card	18 x 24	18 x 24	Sensitized paper	10
	3M-200R Reader-Printer, Enlarger	$1,685	Electrochemical	15	Roll, aperture card	18 x 24	18 x 24	Sensitized paper	10
	3M-400B Reader-Printer, Enlarger	$1,095	Electrochemical	11, 12, 15, 18, 21, 23 to 29 variable	Roll, aperture card, microfiche	10 x 12	8-1/2 x 11	Sensitized paper	5
	111 Printer	$1,795	Dry silver	13 fixed	Aperture card		8-1/2 x 11 (8-1/2 x 14 2/attach.)	Sensitized paper	10
	222 Printer	$1,995	Dry silver	21 fixed	Aperture card		8-1/2 x 11	Sensitized paper	10

MICROFILM, MICROFICHE READER, AND PRINTER COMPARISON CHART (Continued)

Manufacturer	Model	Cost	Processing Method	Magnification Ratio (to nearest whole number)	Microfilm Format Roll, Aperture Card, Microfiche	Screen Size (inches)	Maximum Print Size (inches)	Repro Master	Seconds Per Print
Old Town Corp. 750 Pacific Street Brooklyn, New York 11238	MRP-1 Model A Reader-Printer, Enlarger	[illegible]	Electrostatic	16, 23 fixed	Roll	14 x 14	9-1/2 x 7-1/2	Electrofax	10
Recordak Corp. (See Eastman Kodak Co.)									
Remington Rand Office Systems (Division Sperry Rand Corp.) 122 E. 42nd Street New York, New York 10017	F1824 Reader-Printer	$2,990	Silver	12, 14, or 16 fixed	Roll, aperture card, microfiche	17 x 23	18 x 24	Translucent	35
	F420 Reader	$425		15, 24, 35 variable	Roll, aperture card, microfiche	11 x 11			
	F450 Reader	$325		18 or 24 fixed	Microfiche	11 x 14			
	F468 Reader-Printer	$920		11, 13, 20, 28, 34	Roll, aperture card, microfiche	11 x 11	7 x 9-1/4	Translucent	25
Richardson Camera Co., Inc. 2201 W. Desert Cove Road Phoenix, Arizona 85020	R-100 Reader, Enlarger	Under $6,000		10, 20, 40 fixed	Roll	24-1/2 x 18-1/2			
	VF 550M-4 Reader, Enlarger	$8,900		10, 20 variable	Roll, aperture card, microfiche	30 x 32			
Taylor-Merchant Corp. 48 W. 48th Street New York, New York 10036	Microfiche 8x Reader	$2.50		8 fixed	Roll, aperture card, microfiche				
	Task-master 10x Reader	$2.50		10 fixed	Aperture card				
	Vuedex 5x Reader	$1.00		5 fixed	Aperture card				

MICROFILM, MICROFICHE READER, AND PRINTER COMPARISON CHART (Continued)

Manufacturer	Model	Cost	Processing Method	Magnification Ratio (to nearest whole number)	Microfilm Format Roll, Aperture Card, Microfiche	Screen Size (inches)	Maximum Print Size (inches)	Repro Master	Seconds Per Print
C. S. Industries, Inc (Educational Science Division) 12345 New Columbia Pike Silver Spring, Maryland 20910 (Now produced and marketed by Welch Scientific Co 1300 N. Linden Avenue Skokie, Illinois)	Autotutor Mark II Reader	$1,250		12 fixed	Roll	7 x 9-3/5			
Xerox 961 Lyell Avenue Rochester, New York 14603	1824 Printer, Enlarger		Xerographic	15 fixed	Roll, aperture card, microfiche	4 x 5 (for position only)	18 x 24	Offset, ordinary or translucent paper	21
	Copyflo 24C 24C Printer, Enlarger		Xerographic	15, 20	Roll, aperture card		24x variable length	Offset, ordinary or translucent paper	
	Copyflo 11 Printer, Enlarger		Xerographic	7 to 24	Roll		11x variable length	Offset, ordinary or translucent paper	

MICROFILM EQUIPMENT SPECIFICATIONS CHA

MANUFACTURER AND MODEL NUMBER Legend ● = Standard † = Optional	CAMERAS Price – (to nearest dollar)	Type: R–Rotary, P–Planetary, S–Step/Repeat	Film sizes (mm)	Films both sides at once	Reduction ratio(s): 1	Acceptable Size of Original Document Minimum (in)	Maximum (in)	Film Indicator By feet	By frames	READERS – PRINTERS – ENLARGERS – PROJECTORS – DUPLICATORS Operates as R–Reader, P–Printer, O–Projector E–Enlarger D–Duplicator	Works With These Media 105 mm	70 mm	35 mm	16 mm	8 mm	Aperture cards	Jacketed film	Micro-opaques	Microfiche	Microprocesses	Other	Rate of magnification (power)	Film drive: H–Hand, M–Motor	Enlarges Image to What Size Read size (screen) (in)	Print size (in)	Data Locating A–Automatic V–Visual Other	Makes Duplicates or Copies on Sensitized paper	Ordinary paper	Translucent	Offset plates	Roll film	Aperture cards	Diazo rolls
Atlantic Microfilm Corp.																																			
X-Ray (a)	1925	P	35		11, 14		14 x 17		●																										
F-66	99									R			●	●			●	●		●			19.24	H	8½ x 11		V							
MJF-85A	198									R			●	●	●	●	●	●		●			b	H	10 x 10		V							
8-1	700									RP			●	●	●	●	●	●		●			c	H	12 x 12	6 x 11	V			●		●		
576-75	250									R							●			●			24		9 x 12									
a—to microfilm X-rays only		b—7, 11, 15, 17, 22				c—4½, 8½, 14, 19																													
Bell & Howell Co., Micro-Data Div.																																			
Diplomat	25000	S	105		10, 24		11 x 17																												
Tab-Tronic	3200	R	16		26	2 x 2	16 x any		●																										
Micro-Recorder	2650	R	16	●	24, 30, 44	1 x 2	12 x any		●																										
Micro-Twin	2795	R	16	●	24, 30, 44	1 x 2	12 x any		●	R				●									24, 30, 44	H	8½ x 11				a						
Director I	3350	R	16	●	24, 34, 44	1 x 2	12 x any		●																										
Headliner	350									R	●					●		●					24	H	14 x 14		V	c						
Mascot	150									R	●					●		●					21	H	11 x 11		V	c						
530 U	425									R			●	●		●							15, 24	H	11 x 11		V	a						
530 D	895									RP			●	●		●					d		10.5, 37	H	11 x 11	8½ x 11	V	a	●					
Autofeed	2300									RP				●							d		20, 40	M	14 x 14	8½ x 11	V	ab	●					
Specialist	3995																																		
a—footage indicator		b—alpha numeric marking and scale				c—visible grid				format	d—cartridge				e—archival quality																				
Charles Bruning Co.																																			
1200	12000									EP			●	●		●					o		14, 16	H	5 x 7	b	A		●		●	●		
1170	12975									EP		●											7.5	H		18 x 24	A		●		●	●		
1105	12975									EP	●												4	H		18 x 24	A		●		●	●		
1100	6975									EP			●	●		●					o		14, 16	H	5 x 7	b	A		●		●	●		
a—roll film b—3 sizes 8½ x 11 to 18 x 24																																			
Canon U.S.A., Inc.																																			
CD-F35V1		P	35		7, 27	8.3 x 11.7	33.1 x 46.8	†	†																										
CD-F35V2		P	35		6, 15	7.5 x 10.6	18.9 x 26.6	†	†																										
CD-M1652		R	16	●	22	a	11.7 wide	†	†																										
F-16	1739	R	16		16	a	9 wide	†																											
1-8	1739	R	16	●	34.5	a	9 wide	†																											
K-3		S	b		c		8½ x 11		†																										
CD-F16V3		P	16		16, 22	8.3 x 11.7	11.7 x 16.5	†	†																										
250	2850									D		†	†										1	M										
CD-E135										E		†											23, 26	H		33 x 46.8								
18										RP		†											12.5	M	7.9 x 11	7 x 9.8	A		†					
CD-16A	953									R		†	†										21	M	11 x 11									
300	456									R		†	†	†	†	†	†	†	†				e	H	12 x 12									
Kalprinter	84									D		†			†								1											†
Kaljet	385									D		†			†	†		†	†				1											†
340VC	655									D					†			†	†	†			1						†		†	†		†
340	510									D					†			†	†	†			1						†					†
400	4350									D		†	†										1	M										
16-35																																			
CM-P16A2																																			
Mono-Micro!																																			
a—any small size	b—aperture cards			c—16 std. 20 optional			d—Kalvar film			e—4.6, 18, 15, 21, 23											f—sheet film				c—mono bath			h—daylight loading-tank, mono bath					
Cordell Engineering, Inc.																																			
Varifilm	3600																																		
a—16, 35, 70, 105 mm and 4 x 6		b—150' std., 200' plus optional				c—simultaneous multiple roll processing																															
Data Reproduction Systems																																			
24	1800									PD	●	●	●	●	●	●	●		●	●							V		●	●	●	●		●	
12	1200									PD	●	●	●	●	●	●	●		●	●							V		●	●	●	●		●	
1114	325									R	●	●	●	●	●	●	●		●	●			18, 24	H	11 x 14		A								
8514	1995	P	35		9.5		8½ x 14		●																										
a—sensitized films																																			
Eugene Dietzgen Co. (Driscombe)																																			
P4307-30	240									RO			c	c									30-43		a									
P4307-17	220									RO			c	c									17-23		a									
KJ4314	189									R						●							15-20	H	10½ x 12									
KGA4313	850									R			c	c		●	●		●	●			14¾	H	18 x 24									
KE4312-30	290									R						●	●		●	●			30-43	H	12 x 12									

FILM EQUIPMENT SPECIFICATIONS CHART

READERS – PRINTERS – ENLARGERS – PROJECTORS – DUPLICATORS

PROCESSORS

Operates on: R—Reader, P—Printer, O—Projector E—Enlarger, D—Duplicator	Works With These Media: 105 mm	70 mm	35 mm	16 mm	8 mm	Aperture cards	Jacketed film	Micro-opaques	Microfiche	Micro-positives	Other	Ratio of magnification (power)	Film drive: M—Hand, M—Motor	Enlarges Image to What Size: Read size (screen) (in)	Print size (in)	Data Locating: A—Automatic V—Visual	Makes Duplicates or Copies on: Other	Sensitized paper	Ordinary paper	Transparencies	Offset plates	Roll film	Aperture cards	Diazo rolls	Other	Number of copies per minute	Film Handled: Size(s) (mm)	Type(s) N—Neg., P—Pos., R—Rev.	Plumbing: Self-contained	Separate outlets	Capacity of Developing System: Developer sales (min. gals.)	Fixing sales (min. gals.)	Solutions replenishing system	Solutions recirculation system	Processes rolls to length (ft)	Speed or maximum rate (ft/min)	Self-threading	Film cutter	Fully automatic	Solutions	Temperature Controls: Drying chamber	Other features
E			●	●			●		●			19-24	H	8½ x 11		V																								
E			●	●	●		●		●	●		b	H	10 x 10																										
EP			●	●	●		●		●	●		c	H	12 x 12	8 x 11	V			●		●					6														
R							●		●			24		9 x 12																										
R			●									24, 30, 44	H	8½ x 11		V	o																							
R	●						●		●			24	H	14 x 14		V	c																							
R	●						●		●			21	H	11 x 11		V	c																							
R		●	●				●					15, 24	H	11 x 11		V	o																							
EP		●	●				●				d	10.5, 37	H	11 x 11	8½ x 11	V	o	●			●					4														
EP			●								d	20, 40	M	14 x 14	8½ x 11	V	ob	●			●					5														
																											16, 35	N	●	9	9	1	●	1000	18		●	●	●	e

grid format c—cartridge e—archival quality

EP			●	●		●					o	14, 16	H	5 x 7	b	A		●		●	●				5														
EP		●										7.5	H		18 x 24	A		●		●	●				5														
EP	●											4	H		18 x 24	A		●		●	●				5														
EP			●	●		●					o	14, 16	H	5 x 7	b	A		●		●	●				5														
D			†	†								1	M												d	35'														
E				†								2.3, 26	M		33 x 46.8																									
EP				†								12.5	M	7.9 x 11	7 x 9.8	A		†								3														
R			†	†								21	M	11 x 11																										
R			†	†	†	†	†	†	†	†	†	e	H	12 x 12																										
D			†		†							1												†	d														
D				†		†	†					1												†	d														
D					†	†	†	†				1						†			†	†		†	d														
D					†	†	†	†				1						†			†	†		†	d														
D				†	†							1	M													35'														
																											16, 35	N		½	½	½		100	3 3	†				
																											16	N		½				100	2 3	†				g
																											14	N						25						h

film e—8, 9, 16, 21, 32 f—sheet film g—mono bath h—daylight loading-tank, mono bath

multaneous multiple roll processing

PO	●	●	●	●	●	●	●	●		●	●					V		●	●	●	●		●		a															
PO	●	●	●	●	●	●	●	●		●	●					V		●	●	●	●		●		a															
R	●	●	●	●	●	●	●	●		●	●	18, 24	H	11 x 14		A																									
RO			c	c								30-43		e																											
RO			c	c								17-23		e																											
P						●						15-20	H	10½ x 12																											
R			c	c		●	●		●	●		14¾	H	18 x 24																											
R						●	●		●	●		30-43	H	12 x 12																											

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MICROFILM EQUIPMENT SPECIFICATIONS CHART

MANUFACTURER AND MODEL NUMBER Legend ● = Standard † = Optional	Price — (to nearest dollar)	CAMERAS: Type: R—Rotary, P—Planetary, S—Step/Repeat	CAMERAS: Film sizes (mm)	CAMERAS: Films both sides at once	CAMERAS: Reduction ratio(s): 1	CAMERAS: Acceptable Size of Original Document: Minimum (in)	CAMERAS: Acceptable Size of Original Document: Maximum (in)	CAMERAS: Film Indicator: By feel	CAMERAS: Film Indicator: By frame	READERS — PRINTERS — ENLARGERS — PROJECTORS — DUPLICATORS: Operates as: R—Reader, P—Printer, O—Projector, E—Enlarger, D—Duplicator	Works With These Media: 105 mm	70 mm	35 mm	16 mm	8 mm	Aperture cards	Jacketed film	Micro-opaques	Microfiche	Micro-positives	Other	Ratio of magnification (power)	Film drive: H—Hand, M—Motor	Enlarges Image to What Size: Read size (screen) (in)	Enlarges Image to What Size: Print size (in)	Data Locating: A—Automatic, V—Visual	Makes Duplicates or Copies on: Other	Sensitized paper	Ordinary paper	Translucent	Offset plates	Roll film	Aperture cards	Diazo rolls	Other	Number of copies per minute	Size(s) (mm)
RE4312.17	275									R						●	●		●	●		17-24	H	12 x 12													
RB4308.30	315									R			c	c								30-45		12 x 12		A											
PB4308.17	300									R			c	c								17-24		12 x 12		A											
KM4305	184									R			●			●						15-20	M	10½ x 12		A											
A34306.3 (b)	1595	P	35		16			20 x 24	●																												
A14306.1	1295	P	35		16			20 x 24	●																												
a—opaque to 14 x 14		b—double exposure feature for electrostatic printing								c—rolls																												
Document, ITT																																					
F16	1739	R	16		16	3 x 5	o	●																													
18	1739	R	16	●	34.5	3 x 5	o	●																													
300	456									R	●	●	●	●	●	●	●		●	●		b	H	12 x 12		V											
816A	1050									R				●	●							21	M	11 x 11		V											
Mark 1U	425									R			●	●	●	●	●				●	c	d	11 x 11		V											
Mark 1R	395									R			●	●	●						●	c	d	11 x 11		V											
Mark 1F	350									R						●	●				●	c	d	11 x 11		V											
Mark 2 Std	920									RP			●	●	●	●	●				●	a	d	11 x 11	8½ x 11	V			●								2	
Mark 2½	995									RP			●	●	●	●	●				●	a	d	11 x 11	5½ x 8½	V			●								2	
Mark 1R Engrg	2645									RP	●	●	●	●		●	●		●	●	●	12-14	H	18 x 24	18 x 24	V		●		●							2	
Mark 1R Library	2990									RP	●	●	●	●		●	●		●	●	●	16	H	18 x 24	18 x 24	V		●		●							2	
a—9" width, any length		b—6, 8, 12, 16, 21, 32X				c—16, 18, 35X		d—motor optional		e—10.5, 13.6, 20.1, 27.6, 33.8X																												
Documentation Inc.																																					
1010	200									R				●		●	●		●	●		18	H	10 x 10		V	a										
Mark V	695									RP						●	●		●	●		18	H	8 x 10	8 x 10	V		●									1
Alpha 1010	795									R				●		●	●		●	●		18	H	10 x 10		V	a										
Page Printer	6950									RP	●	●	●	●	●	●	●		●	●		16, 23, 45		8½ x 11	8½ x 11	V	a	●		●	b						
Duplicator	27500									D																									●	15	105
a—360° image rotation		b—with modifications				c—diazo																															
DuKane Corp.																																					
376 90	190									R			●			●						15	H	10½ x 12		V											
376 75	250									R			●	●					●			24	H	11 x 14		V											
27AS	o									R			●	●		●	●		●		b	20	H	11 x 13		V											
a—8125 microfiche, 8155 roll film		b—roll film																																			
Eastman Kodak Co. (Recordak)																																					
Starmatic PVM	595									R				●								24-32	M	12 x 9		V											
Microstrip	1755									RP				●							o	17.5-72.5	H	14 x 14	8.1 x 10.3	V	b	●									2	
Magnaprint PE-1A	1250									RP			●	●		†	†		†			d	M	11 x 11	8.1 x 10.2	V		●									2	
Lodestar PES-1	1995									RP				●								23	M	13.5 x 13.5	8.1 x 10.9	V		●									2	
Filmcard PFC-66	148									R										●		17-22	H	8 x 10													
Filmcard PFC-46.1	213									R										●		e	H	10.5 x 13.75													
Micro-File MRD-2	3395	P	16-35		5.21		26 x 36¾	●																													
Portable RP-1	985	R	16		20	2½ x 2½	12 x any	●																													
Microfilmer 300	1895	R	16	●	20-32	2½ x 2½	9½ x any	●																													
Microfilmer 600	3650	R	16	●	c	2½ x 2½	12 x any	●																													
310A Reader PVA	435									R				●								f	H	12 x 9		V											
Recordak RR-2 35	3795	R	16		35		15 x any	●																													
Recordak RR-1 RR-2	3575	R	8		24		15 x any	●																													
MRG-1	7100	P	35		12-36		48 x 63	●																													
MRD 2-33	3475	P	16		8-30		17½ x 30	●																													
Prostar DVR	3030																																				16-35
a—film strips		b—index tab or holder				c—24, 32, 40, 48		d—11.8, 13.1, 17.1, 19, 23.6, 26, 36, 48			e—30, 33, 36.6											f—30, 34, 132, 40			g—1½ quarts ready mixed			h—daylight loading								
S. K. Elliott Co.																																					
S	4500	P	35		5-14	6¼ x 8¾	17½ x 24½	●	●																													
L'x	7000	P	35		6-30	7½ x 10¼	37½ x 52½	●	●																													
Copy-Jaffrex M	a									RPE			●	●		●	●		●	●		6-30	c	30 x 40	30 x 40	d		●		●	●				e	12	
Copy-Jaffrex V	b									RPE			●	●		●	●		●	●		6-15	H	18 x 24	18 x 24	V		●		●	●				e	12	
a—DI series $7,500 to $30,000		b—V series $2,500 to $4,500				c—hand or motor		d—visual or automatic			e—all sensitized materials																										
Erbon Products, Inc.																																					
1612-L	675									R			●	●		●	●		●			15-22	H	11½ x 16		V											
910-5	495									R			●	●		●	●		●			12-18	H	9 x 10		V											
OMP-63	485									R										o		24	H	9 x 10		V											
a—3 x 5 and 4 x 9																																					

IICROFILM EQUIPMENT SPECIFICATIONS CHART

READERS – PRINTERS – ENLARGERS – PROJECTORS – DUPLICATORS

PROCESSORS

Maximum (in.)	By front / By frame	Film indicator	Operates as: R–Reader, P–Printer, O–Projector, E–Enlarger, D–Duplicator	Works With These Media: 105 mm	70 mm	35 mm	16 mm	8 mm	Aperture cards	Jacketed film	Microfiche	Micro-opaques	Micro-positives	Other	Range of magnification (power)	Film drive: M–Hand, A–Motor	Enlarges Image to What Size: Read size (screen) (in.)	Print size (in.)	Data Locating: A–Automatic, V–Visual	Other	Makes Duplicates or Copies on: Translucent paper	Ordinary paper	Transparency	Other plastics	Bond film	Aperture cards	Diazo rolls	Other	Number of copies per minute
			R				c	c							17-24	H	12 x 12		A										
			R				c	c							30-45		12 x 12		A										
			R												17-24		12 x 12		A										
			R												15-20	H	10½ x 14		A										
20 x 24	●																												
20 x 24	●																												
atic printing		c–rolls																											
a	●																												
a	●																												
			R	●	●	●	●	●	●	●		●	●		b	H	12 x 12		V										
			R				●	●							21	M	11 x 11		V										
			R				●	●	●	●	●	●		●	c	d	11 x 11		V										
			R				●	●	●					●	c	d	11 x 11		V										
			R											●	c	d	11 x 11		V										
			RP				●	●	●	●	●	●		●	e	d	11 x 11	8½ x 11	V			●							2
			RP				●	●	●	●	●	●		●	e	d	11 x 11	5½ x 8½	V			●							2
			RP	●	●	●	●		●	●		●	●	●	12-14	H	18 x 24	18 x 24	V		●		●						2
			RP	●	●	●	●		●	●		●	●	●	16	H	18 x 24	18 x 24	V		●		●						2
B, 35%	d–motor optional		c–10.5, 13.6, 20.1, 27.6, 33.0%																										
			R				●		●	●		●	●		18	H	10 x 10		V	o									
			RP							●	●	●	●		18	H	8 x 10	8 x 10	V		●								1
			R				●			●	●	●	●		18	H	10 x 10		V	o									
			RP		●	●	●			●	●	●	●		16, 23, 45		8½ x 11	8½ x 11	V	o	●		●	b					
			D																								●	15	
			R				●			●			●		15	H	10½ x 12		V										
			R				●	●					●		24	H	11 x 14		V										
			R				●	●		●	●		●	b	20	H	11 x 13		V										
			R				●								24-32	M	12 x 9		V										
			RP				●							a	17.5–25	H	14 x 14	8.1 x 10.3	V	b	●								2
			RP		●	●	●	1	1		1				d	M	11 x 11	8.1 x 10.2	V		●								2
			RP				●								23	M	13.5 x 13.5	8.1 x 10.9	V		●								2
			R									●			17-22	H	8 x 10												
			R									●			e	H	10.5 x 13.25												
26 x 36½	●																												
12 x any	●																												
9½ x any	●																												
12 x any	●																												
			R				●								f	H	12 x 9		V										
15 x any	●																												
15 x any	●																												
45 x 63	●																												
17½ x 30	●																												
d–11.9, 13.7, 1			.1, 19, 22.6, 36, 38	c–26, 28, 36.8											f–28, 24, 32, 40		g–1½ quarts ready mixed													
7½ x 24½	●	●																											
7½ x 52½	●	●																											
			RPE		●	●		●	●		●	●			6-30	c	30 x 40	30 x 40	d		●		●	●		a	12		
			RPE		●	●		●	●		●	●			6-15	H	18 x 24	18 x 24	V		●		●	●		a	17		
c–hand or motor			d–visual or automatic												e–all sensitized materials														
			R			●	●		●	●		●			15-22	H	11¾ x 16		V										
			R			●	●		●	●		●			12-18	H	9 x 10		V										
			R					o							24	H	9 x 10		V										

Film Handled: Size(s) (mm)	Type(s): N–Neg., P–Pos., B–Rev.	Self-contained	Separate cabinet	Developer sales (min. gals.)	Fixing sales (min. gals.)	Solutions replenishing system	Solutions recirculation system	Processes rolls to length (ft)	Speed at max. rem rate (ft/min)	Self-threading	Film cutter	Fully automatic	Solutions	Drying cabinet	Other features	Temperature Controls
16-35	NP	●	o	o	●			200	5	●	●	●	●		h	

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MICROFILM EQUIPMENT SPECIFICATIONS CHAR

MANUFACTURER AND MODEL NUMBER (Legend: ● = Standard; † = Optional)	CAMERAS: Price – (to nearest dollar)	Type: R—Rotary, P—Planetary, S—Step/Repeat	Film sizes (mm)	Films both sides of card	Reduction ratio(s): 1	Acceptable Size of Original Document: Minimum (in)	Maximum (in)	Film Indicator: By foot	By frame	READERS – PRINTERS – ENLARGERS – PROJECTORS – DUPLICATORS: Operates as: R—Reader, P—Printer, O—Projector, E—Enlarger, D—Duplicator	Works With These Media: 105 mm	70 mm	35 mm	16 mm	8 mm	Aperture cards	Jacketed film	Micro-opaques	Microfiche	Micro-positives	Other	Rate of magnification (power)	Film drive: H—Hand, M—Motor	Enlarges Image to What Size: Read size (screen) (in)	Print size (in)	Data Locating: A—Automatic, V—Visual	Other	Makes Duplicates or Copies on: Sensitized paper	Ordinary paper	Translucent	Offset plates	Roll film	Aperture cards	Diazo rolls	Other
Fairchild-Miller, Republic Aviation Div.																																			
Mark II Microvue										R											a	240	M	6.5 x 6.5		A									
Mark III Microvue										R											b	260	M	9 x 12		A									
Mark IV										R											c	260	M	12 x 15		A									
a—3801 images on 4 x 4 laminated film chip; b—6801 images on 4 x 6 laminated film chip; c—6052 images on 4 x 6 laminated film chip																																			
Fuji Photo Film U.S.A., Inc.																																			
L2		P	35-16		12, 20		37 15/16 x 53½	●	●																										
S		P	35-16		5, 14		17½ x 24 13/16	●	●																										
T										R			●	●			●					a	H	13¾ x 13¾											
Q7										RP			●	●		●	●		●			12.5	H	15¾ x 22⅝	16½ x 22¾	V		●		●					
Q4, Q4D, Q4F										RP			●	●		b	●		c			d	H	11¼ x 11¼	8¼ x 11¾	V		●		●					
a—11, 16, 23, 30; b—on Model Q4D; c—on Model Q4F; d—8.3, 12.8, 17.5, 23.3 on Model Q4; 6.3 on Model Q4D; 17.5 on Model Q4F																																			
Karl Heitz, Inc.																																			
Robot	299	S	35		4.4, 17.5	4 x 5	12 x 17		●																										
Alpa	400	S	35		10, 1	any	any		●																										
Robot 16										RO			●	●	●	●	●		●	●		30	H	8½ x 9½											
Robot 35										RO			●	●	●	●	●		●	●		30	H	13½ x 13½											
Houston Fearless Corp.																																			
L16NP																																			
L16/35M																																			
L16M																																			
L16P																																			
Sepratron	a																																		
Filmcard	3000									R									●			24	M	9 x 12		A		●							
Filmcard	19500	S	c		20, 24		d		●																										
a—varies with style (size); b—sheets and rolls; c—105 x 148.75mm; d—books to 8½ x 11																																			

MICROFILM EQUIPMENT SPECIFICATIONS CHART

CAMERAS					READERS — PRINTERS — ENLARGERS — PROJECTORS — DUPLICATORS																											PROCESSORS															
	Acceptable Size of Original Document		Film Indicator			Works With These Media													Enlarges Image to What Size		Data Locating		Makes Duplicates or Copies on									Film Handled		Plumbing		Capacity of Developing System									Temperature Controls		
Reduction ratio(s)	Minimum (in)	Maximum (in)	By foot	By frame	Operates as: R—Reader, P—Printer, O—Projector, E—Enlarger, D—Duplicator	105 mm	70 mm	35 mm	16 mm	8 mm	Aperture cards	Jacketed film	Micro-opaques	Microfiche	Micro-positives	Other	Rate of magnification (power)	Film drive: H—Hand, M—Motor	Read size (screen) (in)	Print size (in)	A—Automatic V—Visual	Other	Sensitized paper	Ordinary paper	Translucent	Offset plates	Roll film	Aperture cards	Diazo rolls	Other	Number of copies per minute	Size(s) (mm)	Type(s) N—Neg., P—Pos., R—Rev.	Self-contained	Separate outlets	Developer solns. (min. gals.)	Fixing solns. (min. gals.)	Solutions replenishing system	Solutions recirculation system	Processes rolls to length (ft)	Speed at maximum rate (ft/min)	Self-threading	Film cutter	Fully automatic	Solutions	Drying chamber	Other features
					R											a	240	M	6.5 x 6.5		A																										
					R											b	260	M	9 x 12		A																										
					R											c	260	M	12 x 15		A																										
b—[illegible] images on 4 x 5 laminated film chip c—[illegible] images on 4 x 5 laminated film chip																																															
12, 30		37 15/16 x 52 1/2	●	●																																											
5, 14		17 5/8 x 24 5/8	●	●																																											
					R			●	●			●					a	H	13 1/2 x 13 1/2																												
					RP			●	●		●	●		●			12.5	H	15 5/8 x 22 5/8	16 1/2 x 23 1/2	V		●		●																						
					RP			●	●		b	●		c			d	H	11 1/2 x 11 1/2	8 1/2 x 11 1/2	V		●		●																						
…n Model Q4P d—8.5, 13.5, 17.6, 20.5 on Model Q4; 6.5 on Model Q4D; 11.5 on Model Q4P																																															
4.4, 17.5	4 x 5	12 x 17		●																																											
10, 1	any	any		●																																											
					RO			●	●	●	●	●		●	●		30	H	8 1/2 x 8 1/2																												
					RO			●	●	●	●	●		●	●		30	H	13 1/2 x 13 1/2																												
																																16	NR		●	5	10	†	†	1200	75				†	†	●
																																16, 35	NP		●	5	10	†	†	1200	75				†	†	●
																																16	NP		●	5	10	†	†	1200	75				†	†	●
																																	NPR		●	5	10	†	†	1200	75				†	†	●
																																16, 105	NP	●		4	a	●	●	b	10	●			●	●	●
					R									●			24	M	9 x 12		A		●								2																
20, 24		d		●																																											
…ils c—105 x 148.75mm d—books to 8 1/2 x 11																																															

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MICROFILM EQUIPMENT SPECIFICATIONS CHART

MANUFACTURER AND MODEL NUMBER (Legend: x = Standard, w = Optional)	Price — (to nearest dollar)	CAMERAS: Type: S—Rotary, P—Planetary, S—Step/Repeat	CAMERAS: Film sizes (mm)	CAMERAS: Films both sides at once	CAMERAS: Reduction ratio(s): x	CAMERAS: Acceptable Size of Original Document: Minimum (in)	CAMERAS: Acceptable Size of Original Document: Maximum (in)	CAMERAS: Film Indicator: By feet	CAMERAS: Film Indicator: By frames	READERS — PRINTERS — ENLARGERS — PROJECTORS — DUPLICATORS: Operates as: R—Reader, P—Printer, E—Projector, E—Enlarger, D—Duplicator	Works With These Media: 105 mm	70 mm	35 mm	16 mm	8 mm	Aperture cards	Jacketed film	Micro-opaques	Microfiche	Micro-positives	Other	Rate of magnification (power)	Film drive: H—Hand, M—Motor	Enlarges Image to When Size: Read size (across) (in)	Enlarges Image to When Size: Print size (in)	Data Location: A—Automatic, V—Visual	Makes Duplicates or Copies on: Other	Sensitized paper	Ordinary paper	Translucent	Offset plates	Roll film	Aperture cards	Discs rolls	Other	Number of copies per minute
Addison Photographic Industries, Inc.																																					
35	100																																				
a—convertible to 3 x 5 slides		c—fold flat, accessory cam available								P												a	6.5	H	10 x 10		V								b		
EBAC Corp., Information Records Div.																																					
9950 (c)	1800																																				
9955	65300 d									D																											
9952	2845									D																											
9956	6800	P	35		8.36		45 x 62			RP													15	H	18 x 24	18 x 24										35	
9951	4495	P	35		8.30		37 x 52																														2
9972	400																																				
9971	300									R													24, 30	H	14 x 22		V										
9949	210									R													24, 30	H	14 x 15		V										
9948 (c)	1025									R												b	6.5, 15	H	8 x 10		V										
1 54 (c)	2300									D												b														4	
x—diazo copier b—roll film c—thermal copier d—rental $1760										D												b														8	
Irish Business Products																																					
16.24	2845																																				
105	4200									RP												a	14.7	H	18 x 24	18 x 24	V									2	
UT35.5	1950									RP													4		18 x 24	18 x 24	V									2	
b—rolls																																					
Kalvar Corp.																																					
Kalvarsatic	15000	P	16		20																																
K-10	895									PD																											
KID-710	325																																			4	
Activator 240	325									D												b															
Exposer 200	545									PD																										6	
450	11625									PD														M												6	
420	15762									PD														M												30'	
400	6950									PD														M												185'	
a—used with Model 210 dry thermal developer b—roll film 10" width, 10' length										c—dry, electrostatic finish de velopor													d—used with Model 240		e—roll f	s to 9" width								f—in-line dry st		
Kenfel & Esser Co.																																					
522012										P													15		18 x 24												
522017										R													15		18 x 24												
522033										RP													14½		18 x 24	18 x 24											
522034										R													15		10¼ x 12												
522030 (c)										R													15		10¼ x 12												
522038										R													15		10½ x 12												
522026		P	35		12-30																																
522001		P	105 e		4-11 b		37⅛ x 83⅛																																
522049							44 x 66			P e													12, 30														
522025										R																											
522021										RP													4		15 x 23												
522004										R													3		4¼ x 7												
522045										RP													4		18 x 24	18 x 24											
522008										D							d																				
522013																																					
a—35mm optional b—13 to 84 on 35mm c—35mm d—diazo and Kalvar										e—for fully aperture cards f—roll sizes to 105mm																													
Kleis-Ve Industries, Inc.																																					
X-38	5950									D																	A									12	
a—automatic operation, gives unstable copies by diazo process																																					
Frederic Luther Co.																																					
	950	F	16		18		10 x 15																														
Microcard Corp.																																					
SR-1	28000	S	105-148		18-20	6.9 x 8.6	12.7 x 18.3																														
EL-4	19000									RP													16.3	M		8½ x 11											
Mark VII	450									R													23		9⅛ x 10¼		V									12	
Mark IV	350									R													18		9⅛ x 11		V										
PR 5	135									R													16.5, 22		7⅛ x 9⅛		V										
a—automatic filler b—no tungsten or fluorescents c—projector																																					

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MICROFILM EQUIPMENT SPECIFICATIONS CHART

CAMERAS — READERS — PRINTERS — ENLARGERS — PROJECTORS — DUPLICATORS — PROCESSORS

Acceptable Size of Original Document		Film Indicator		Operates as: R—Reader, P—Printer, O—Projector E—Enlarger, D—Duplicator	Works With These Media											Rate of magnification (power)	Film drive: H—Hand, M—Motor	Enlarges Image to What Size		Data Locating	Makes Duplicates or Copies on										Film Handled		Plumbing		Capacity of Developing System						Temperature Controls			
Minimum (in.)	Maximum (in.)	Dry front	Dry process		105 mm	70 mm	35 mm	16 mm	8 mm	Aperture cards	Jacketed film	Microopaque	Microfiche	Microprint	Other			Read size (screen) (in.)	Print size (in.)	A—Automatic V—Visual Other	Bookfold paper	Ordinary paper	Transparency	Offset plates	Roll film	Aperture cards	Diazo rolls	Other	Number of copies per minute	Size(s) (mm)	Type(s) N—Neg. P—Pos. E—Env.	Self-contained	Separate cabinet	Developer sales (min. gals.)	Fixing sales (min. gals.)	Solutions replenishing system	Solutions recirculation system	Processes rolls to length (ft)	Speed or maximum rate (ft/min)	Self-threading	Film cutter	Fully automatic	Solutions	Drying chamber	Other features
				R						●					a	6.5	H	10 x 10		V							b															
case available																																										
				D		●		●		●																		a														
				D		●		●		●																																
				RP		●		●		●						15	H	18 x 24	18 x 24		●	●						35														
	45 x 63		●																									2														
	37 x 52		●																																						
				R						●	●		●			24, 30	H	14 x 22		V																					
				R						●	●		●			24, 30	H	14 x 15		V																					
				R				●		●						6.5, 15	H	8 x 10		V																					
				D				●		●					b																										
				D				●		●					b																										
d—rental $1190																												4														
				RP		●		●		●					a	14.7	H	18 x 24	18 x 24	V	●	●	●					2														
				RP	●											4		13 x 24	19 x 24	V	●	●	●					2														
																													16, 35	NP	●	2	1	●	100	5	●			a
		●																																							
				PD				●	●	●					b														4							20						a
				D				●																																	c
				PD		●	●	●									M									●		6														d
				PD				●	●								M									●		30'		R												f
				PD				●	●								M									●		185'		NPR												f
film 16" width, 16" length				e—dry, electrostatic cloth developer												d—used with Model 240				e—roll film to 9" width										f—in-line dry thermal development (retrofit)													
				R		●										15		18 x 24																								
				R						●						15		18 x 24																								
				RP				●		●						14½		18 x 24	18 x 24																								
				R								●				15		10½ x 12																								
				R			f	f		●						15		10½ x 12																								
	37½ x 52½		●	R						●						19		10½ x 12																								
	44 x 66			Pc												12, 30																										
				R												4		15 x 23																								
				RP																																						
				R		●										3		4½ x 7																								
				RP		●										4		18 x 24	18 x 24			●	●																				
				D					d														●																		
d—diazo and Kalvar				e—for 8x1 special aperture cards												f—all sizes to 105 mm																										
				D																																					
ance																					A				●		of 13														
	10 x 15		●																																						
x 8.6	12.7 x 18.3		●																																						
				RP	●							●				16.3	M		9½ x 11			●																				o
				R							●	●				23		9½ x 16½		V								12														b
				R							●	●				18		9½ x 11		V																						
				R					●	●		●				16.5, 22		7½ x 9½		V																						c
lector																																									

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13. ABSTRACT

This document is a partial review and summary of the state-of-the-art in information storage and retrieval systems concentrating specifically on microfilm based systems for document storage and retrieval. The data contained herein provides typical examples of such systems including cost data.

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